B9

SOIL TAXONOMY




Subroto Ps

WIMAYA PRESS UPN "Veteran" YOGYAKARTA

SOIL TAXONOMY

(Order - Suborder - Great Group)

Subroto Ps

Perpustakaan Nasional : Katalog Dalam Terbitan (KDT)

Soebroto Ps

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INTISARI

Buku ini merupakan bentuk penyederhanaan atau disusun dengan metode yang sangat mudah yaitu dengan menggunakan tanda (+) sebagai syarat yang harus dipenuhi dan tanda (-) sebagai syarat yang dipenuhi secara fakultatif dari Soil Taxonomy A Basic of Soil Classification For Making and Interpreting Soil Survey edisi kedua sebagai hasil penyempurnaan dari Soil Taxonomy A Basic of Soil Classification For Making and Interpreting Soil Survey edisi pertama tahun 1975 yang selalu mengalami perbaikan setiap 2 sampai 4 tahun sekali sampai diterbitkan Soil Taxonomy A Basic of Soil Classification for Making and Interpreting Soil Survey edisi kedua tahun 1999 yang di lanjutkan perbaikannya melalui Key to Soil Taxonomy tahun 2003. Selanjutnya pembaca, pengguna khususnya surveyor akan lebih mudah untuk mempelajari, memahami, serta mengaplikasikannya, sehingga dapat membedakan apa yang dimaksud dengan bahan organic, bahan mineral, tanah organic, tanah mineral, dan dengan mudah mengenal karakteristik epipedon, sub horizon, serta regime lengas tanah dan yang lainnya yang selanjutnya pengguna dapat menggunakan sifat, ciri, dan karakteristik tersebut guna mengklasifikasikan tanah secara internasional sampai pada tingkat Greatgroup (Order – Subordert – Greatgroup) dengan mudah, tepat dan benar mengikuti Soil Taxonomy USDA atau Klasifikasi Tanah secara Internasional.

KATA PENGANTAR

Buku ini merupakan bentuk penyederhanaan atau disusun dengan metode yan sangat mudah yaitu dengan menggunakan tanda (+) sebagai syarat yang harus dipenuhi da tanda (-) sebagai syarat yang dipenuhi secara fakultatif dari Soil Taxonomy A Basic Soil Classification For Making and Interpreting Soil Survey edisi kedua sebagai has penyempurnaan dari Soil Taxonomy A Basic of Soil Classification For Making an Interpreting Soil Survey edisi pertama tahun 1975 yang selalu mengalami perbaikan setia 2 sampai 4 tahun sekali sampai diterbitkan Soil Taxonomy A Basic of Soil Classificatio for Making and Interpreting Soil Survey edisi kedua tahun 1999 yang di lanjutka perbaikannya melalui Key to Soil Taxonomy tahun 2003.

Soil Taxonomy merupakan Klasifikasi Tanah International yang disusun secar sistematis, sangat rinci, dan komprehensip. Untuk keperluan klasifikasi menggunaka system ini perlu memahami sifat dan ciri yang dipergunakan dalam klasifikasi antara lai memahami sifat dan ciri bahan organik, bahan mineral, tanah organik, tanah minera epipedon,, sub horizon, regim lengas tanah, dan lain-lainnya, buku ini tebalnya lebih da 800 halaman Hal ini sangatlah tidak mudah untuk dihafal dan diingat sehingga untu keperluan lapangan buku ini mestinya selalu dibawa padahal buku ini sangat tebal beri lebih dari 800 halaman .

Buku ini disusun tidak tebal hanya terdiri dari 134 halaman sehingga denga mudah untuk dibawa kelapangan dan selain cara penyajiannya sangat sederhana, buku in menggunakan bahasa Inggris yang lebih sederhana dibanding buku aslinya , mempuny tujuan membantu agar supaya pembaca, pengguna, khususnya surveyor lebih mudah untu memahaminya sehingga dapat melakukan klasifikasi tanah dengan mudah, tepat dan benar hasil klasifikasi ini juga dapat digunakan sebagai pendamping atau padanan da Klasifikasi Tanah Nasional, selanjutnya dapat digunakan sebagai alat komunikasi secar Internasional.

Kritik dan saran dari pembaca dan pengguna sangat saya harapkan

Akhir kata terselesainya buku ini kepada semua pihak yang telah membantu say ucapkan terima kasih khususnya kepada saudara Ari Visianto.

Yogyakarta, Agustus 2007

Penyusun

FOREWORD

This book is a form of simplification of the Soil Taxonomy A Basic of Soil Classification For Making and Interpreting Soil Survey second edition as a result of the improvement of the Soil Taxonomy A Basic of Soil Classification For Making and Interpreting Soil Survey first edition in 1975 that always improved every 2 to 4 years, until to Soil Taxonomy A Basic of Soil Classification for Making and Interpreting Soil Survey second edition in 1999 published and to be continued improvement through Key to Soil Taxonomy in 2003, and used sample methode this text properties are proceeded by sign (+) meaning "and" (obligatory), and sign (-) meaning "or" (facultative, possible)

The Soil Taxonomy is the International Soil Classification very detailed, systematically organized, and comprehensive, for the purposes of classification using this system need to understand deeply the nature and properties used in classification, for the example, understand the nature and properties of organic materials, mineral materials, organic soil, mineral soil, epipedon, sub-horizon, soil moisture regime, and others, that is not easy to remember all so that for the purposes of the field classification this book should always be taken whereas this very thick book contains over 800 pages.

This book is not thick, contents 134 pages, easier to bring it to the field and served, with simple layout, and sample English language compared with the original book. The main goal is to help the readers, users, and especially to surveyor in order easier to understand so that it can make soil classification with the simple way, accurate and correct, the results of this classification can also used as the equivalency of our National Soil Classification which can be used as a tool of international communication.

I am very expecting criticism and suggestions from readers and users.

Finally, for the finishing of this book to all those who have helped me I would like to say thank you very much especially to the brother Ari Visianto.

Yogyakarta, August 2007

Writer

CONTENTS

THE SOIL THAT WE CLASSIFY, AND BURIED SOILS

THE SOIL THAT WE CLASSIFY.

Soil is the nature bodies, made of mineral and organic materials, that cover much of earth's suface, contain living matter and can support vegetation out of doors, and have in places been changed by human activity.

Soils consists of the horizons near the earth's surface which, in contrast to the underlying rock material, have been altered by interactions of the climate, parent materials, living organisms, relief, and over time.

BURIED SOILS.

A soil is considered to be a buried soil if it is covered with a surface mantle of new soil material that is either ≥50 cm thick, or 30 – 50 cm thick and has a thicknes that equals at least half the total thicknes of the named diagnostic horizons that are preserved in the buried soil. A surface mantle of new material less than 30 cm thick is not considered in the taxonomy.

DISTINCTION BETWEEN MINERAL SOIL AND ORGANIC SOIL

Introduction

Soils contain both mineral and organic components in very different proportion, although normally one of both dominate. Generally the limit between " mineral soils " and " organic soils " has been put at 20 – 35 % (by weight) of organic matter. For purposes of taxonomy, it is necessary to define first " mineral materials " and " organic materials ", in order to define afterwards " mineral soils " and " organic soils ".

Mineral Soil Materials (less than 2,0 cm in diameter)

(-) 1. Is saturated with water for less than 30 days (cumulative), and having < 20 % organic carbon.(by weight)

(-) 2. Saturated with water for long periods (unless artificially drained), and having :

(-) 2.1. < 18 % organic carbon if the mineral fraction has ≥60 % clay

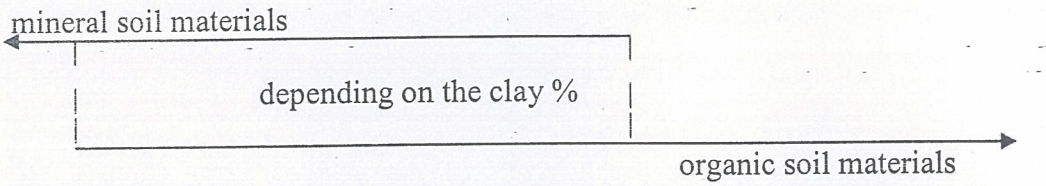
(-) 2.2. < 12 % organic carbon if the mineral fraction has = 0 % clay

(-) 2.3. < 12 % + (clay percentage multiplied by 0,1) if the mineral fraction < 60 % clay

Other soil material are organic

0 10 20 30 40 50 60 % clay

12 13 14 15 16 17 18 % org. Carbon 100



Definition of Mineral Soils

(-) 1. Mineral soil materials that meet one or more :

(-) 1.1 Overlie cindery, fragmental, or pomecius and or have voids filled, ≤ 0 % organic matter and directly below this materials either densic, (para) lithic.

(-) 1.2. When added with underlying cindery, fragmental, or pomecius, total thicknes > 10 cm from 0 – 50 cm depth.

(-) 1.3. Thicknes 1/3 or > 10 cm to densic, (para) lithic.

(-) 1.4. If saturated with water ≥ 30 days per year in normal year (or artificially drained) and have upper boundary within 40 cm.

(-) 1.4.1. Thicknes < 60 cm > 3/4 more fibers or BV moist < 0,1 g/cm^3.

(-) 1.4.2. Thicknes < 40 cm < 3/4 moss fibers or BV moist < 0,1 g/cm^3 or sapric or hemic.

(-) 2. More 20 % by volume mineral soil material to 50 cm depth or to glacic, densic, (para)lithic contact whichever is shallower.

(-) 2.1. Permafrost within 100 cm of soil surface

(-) 2.2. Gelic material within 100 cm of the soil surface and permafrost within 200 cm of the soil surface.

Organic Soil

Organic soils have organic soil materials :

(+) 1. Do not have andic soil properties in 60 % or more of 0 – 60 cm depth or densic, (para) lithic contact or duripan if shallower.

(+) 2. (-) 2.1. Overlie cindery, fragmental, or pomecius and or have filled more 10 % organic matter and directly below this materials either densic, (para) lithic contact.

(-) 2.2. When added with underlying cindery, fragmental, or pomecius, total ≥40 cm between the soil surface and depth of 50 cm.

(-) 2.3. Constitute 2/3 or more of the total thicknes of the soil to densic, (para) lithic contact and have no mineral horizon or mineral horizon with a total thicknes of ≤10 cm.

(-) 2.4. Are saturated with water for ≥30 days per year in normal year (artificially drained) and have upper boundary within 40 cm

(-) 2.4.1. Thicknes > 60 cm if 3/4 moss fibers and BV moist < 0,1 g/cm³

(-) 2.4.2. Thicknes > 40 cm either sapric or hemic material or fibric material with < 3/4 (by volume) moss fibers and BV moist > 0,1 g/cm³

(-) 2.5. Are 80 % or more by volume from the soil surface to a depth 50 cm or to either glassic layer, densic, (para) lithic, contact whichever shallower.

In This text the properties are proceeded by :

(+) meaning " and " (obligatory)

(-) meaning " or " (facultative, possible)

HORIZONS AND PROPERTIES DIAGNOSTIC FOR MINERAL SOIL

1. EPIPEDONS

The epipedon is a diagnostic surface horizon. It includes :

- the upper part of the soil darkened by organic matter (mostly A_1, Ap)
- the upper eluvial horizons (mostly A_2, A_3)

Remarks

- Epipedon is not a synonym for A horizons, because it many include part or all of the B horizon if the organic matter extends from the A into the B.
- Recent alluvial, colluvial, or eolian deposits, that are finely stratified, are not included in the concept of epipedon, because pedogenetic features are not sufficiently developed.
- An Ap horizon overlying the above mentioned materials is also not an epipedon.
- In virgin soils the properties of the epipedon should be determined after the surface 18 cm have been mixed; this is to avoid in classification of a soil as the result of plowing.

Description of the diagnostic epipedons

MOLLIC Epipedon

Concept : Surface horizons, thick, dark, humus – rich, highly base saturated (dominant Ca^{++}, Mg^{++}), with "soft" structure.

Genesis : Underground decomposition of organic residues (roots, surface residues taken underground by animal), mainly of grasses (steppes of N and S America, Europe, Asia). Clays 2/1.

Properties (Simplified)

(+) 1. When dry, either or both ;

(-) 1.1. Structural unit or secondary unit Ø ≤30 cm

(-) 1.2. Moderatly hard or softer, rupture – resistance class

(+) 2. Rock structure, including fine (< 5 mm) stratifications in less than ½ of the volume of all parts.

(+) 3. One of the following ;

(-) 3.1. All of the following :

(+) 3.1.1. Colors : Value ≤3 (moist), ≤5 (dry)

(+) 3.1.2. Chroma ≤3 (moist)

(+) 3.1.3. If the soil has C horizon, color value at least 1 Munsell unit lower or chroma at least 2 unit lower (moist and dry)than that of C horizon or epipedon organic carbon ≥0.6 % than C horizon.

(-) 3.2. A fine earth fraction that has calcium carbonate equivalent of 15 to 40 % and color value and chroma moist ≤3.

(-) 3.3. A fine earth fraction that has calcium carbonate equivalent of ≥40 % and color value moist ≤5.

(+) 4. Base saturation : V ≥50 % (NH_4OAc method)

(+) 5. Organic carbon ;

(-) 5.1. 2.5 % if the epipedon has color value moist of 4 or 5.

(-) 5.2. ≥0.6 % organic carbon than that of the C horizon (if one occurs) color value 1 unit Munsell lower or chroma 2 munsell unit lower (moist and dry) than C horizon.

(-) 5.3. ≥0.6 %

(+) 6. Thickness ;

(-) 6.1. ≥25 cm if the texture is loamy fine sand or coarser.

(-) 6.2. ≥10 cm if epipedon is finer than loamy fine sand and it's directly rest on R.

(-) 6.3. ≥18 – 25 cm and one – third or more of the total thickness.

(-) 6.4. ≥18 cm if none above condition

(+) 7. Phosphate < 1500 ppm (soluble in 1 % citric acid)

(+) 8. ≥ 3 months (cumulative) in some part in 7/10 years when the soil temperature at 50 cm depth is ≥5℃ (unless irrigated)

(+) 9. n-value : < 0,7

ANTHROPIC Epipedon

Concept : Surface horizons, formed under long – continued land use by man, resembling very much the mollic epipedon, except for P_2O_5 and dry period.

Genesis : Long – continued land use by man either as a place for residence or for growing crops.

Properties (simplified) :

Idem as mollic epipedon, except :

(-) 1. ≥1500 ppm (mg/kg) soluble in 1 percent citric acid an regular decrease in P_2O_5 to depth 125 cm.

(-) 2. Dry ≥9 month (cumulative), if not irrigated.

UMBRIC Epipedon

Concept : Surface horizons, resembling very much the mollic epipedon except for the low base saturation.

Properties (simplified) :

Idem as the mollic epipedon, except :

(+) 1. Base saturation : V < 50 % (NH_4Ac method).

HISTIC Epipedon

Concept : Thin organic horizons, (if virgin) or horizons with very high organic matter content (if plowed and the peat being mixed with mineral material), at or near the surface, saturated with water ≥30 comulative days (unless artificially drained).

Genesis : Acummulation of organic material at the surface under very wet circumstances.

Properties (simplified) :

(+) 1. Humidity : Saturated with water ≥30 comulative days in > 5/10 year (artificially drained)

(-) 2. Surface horizons of organic soil materials, with thickness :

(-) 2.1. 20 – 60 cm thick and either contains 25% by volume sphagnum fibers if undecomposition or with bulk density , moist < 0.1.

(-) 2.2. 20 – 40 cm thick if decomposed or with bulk density > 0.1.

(-) 3. Ap horizons of organic soil materials to a depth of 25 cm, has an organic carbon content

(-) 3.1. ≥16 % if the mineral fraction ≥60% clay.

(-) 3.2. ≥8 % if the mineral fraction 0 % clay.

(-) 3.3. ≥8 % + (clay percentage devided by 7.5) if the mineral fraction < 60 % clay.

FOLISTIC Epipedon

Concept : The folistic epipedon is defined as layer (one or more horizons) saturated < 30 cumulative days in normal years.

Properties (simplified) :

(-) 1. ≥20 cm thick and contains ≥75 % (by volume) spagnum fibers has BV moist < 0.1 or ≥15 cm thick.

(-) 2. Is an Ap horizons that when mixed to depth of 25 cm, has organic carbon content :

(-) 2.1. ≥16 % if the mineral fraction ≥60 % clay.

(-) 2.2. ≥8 % if the mineral fraction 0% clay.

(-) 2.3. ≥8 % + (clay percentage devided by 7.5) if the mineral fraction < 60 % clay.

PLAGGEN Epipedon

Concept : Man-made surface layer, humus-rich, thick.

Genesis : Sods or other materials, after having been used for beeding livestock, is spread as manure on the field, producing a very thick Ap horizon (plaggen technique)

Heath sod → dark grayisch plaggen

Forest sod → brownish plaggen.

MELANIC Epipedon

Concept : The melanic epipedon is a thick black horizon at or near the soil surface which contains high concentrations of organic carbon.

Genesis : Large amounts of root redidues supplied by a gramineous vegetation.

Properties (simplified) :

(+) 1. An upper boundary at, or within 30 cm, with andic soil properties.

(+) 2. In layer with a accumulative thickness of ≥30 cm within a total thickness of 40 cm ,

(+) 2.1. Andic soil properties throughout,

(+) 2.2. A colour value, moist, and chroma ≤2 throughout, and melanic index of ≤1.70 throughout,

(+) 2.3. ≥6 % organic carbon as a weighted average, and ≥4 % organic carbon in all layer.

OCHRIC Epipedon

Concept : Surface horizon, mostly thin mostly light colored, mostly humus-poor.

Properties (simplified) :

The ochric epipedon is that where at least one requirement is lacking to be mollic, umbric, anthropic, plaggen, histic, folistic, and melanic epipedon.

2. DIAGNOSTIC SUBSURFACE HORIZONS

The Diagnostic subsurface horizons are lying :

- Below an epipedon,
- Below a leaf litter,
- At the surface (after truncation).

They are mostly B horizons, but may include a part of the A horizons.

ARGILLIC Horizon

Concept : Horizons that contains illuvial layer-lattice sillicate clays, forms below an elluvial horizons, but may be at the surface if the soil has been partially truncated. Concurrent neoformation of clay is normal.

Genesis : Migration of clay, carried by water, from A to B horizons. "Precipitation" of the clay on the peds surfaces and in the pores. Concurrent neo formation of clay.

Time : A few thousands of years.

Vegetation : Any.

Climate : Alternatively wet and dry periods.

Morphology :

- Distinctly more clayey than the overlying elluvial horizon and than the underlying parent material.

- Cutans of oriented clay on the peds and in the pores, especially at the bottom of the horizon.
- Fine clay (< 0.2 μ)/ total clay (< 2μ) ratio of the argillic horizon is larger than in the elluvial horizon or the underlying horizon.
- Structure of weathered rock (saprolite) is not evident or has disappeared in more than half of the volume.
- Minerals resistant to weathering are less abundant than the elluvial horizon or in the underlying horizon.
- Nearly parallel to the surface.
- Exterior color of the peds is redder or darker than the interior color.

Properties (simplified) :

All argillic must meet both of the following :

(+) 1. Thickness and illuviation

(+) 1.1. Thickness

(-) 1.1.1. Bt Horizon loamy or clayey :

- ≥1/10 of the sum of all underlying horizon, but always ≥7.5 cm,
- > 15 cm if A horizon > 150 cm.

(-) 1.1.2. Bt horizon sandy or loamy sand at least 15 cm.

(-) 1.1.3. Lamellae ≥0.5 cm, total thickness > 15 cm.

(+) 1.2. Illuviation

(-) 1.2.1. Oriented clay bridging sand grains.

(-) 1.2.2. Clay film lining pores

(-) 1.2.3. Clay film on both vertical and horizontal of surface peds.

(-) 1.2.4. Thin section with oriented clay ≥1% of the section.

(-) 1.2.5. If the COLE is ≥0.04, distinct wet and dry , ratio fine clay/total clay illuviation 1.2 than elluviation.

(+) 2. Clay content must increase from A to Bt in vertical distance ≤30 cm :

	% clay in A	% clay in B
(-)	< 15 %	≥% A + 3 %
(-)	15 – 40 %	≥% A x 1.2 %
(-)	≥40 %	≥% A + 8 %

NATRIC Horizon

Concept : Special kind of argillic horizon with special structure and with excangeable Na.

Properties (simplified) :

(+) 1. All properties of the argillic horizon

(-) 2. Structure :

(-) 2.1. Columnar or prismatic in some part which may break to blocks.

(-) 2.2. Both blocky structure and eluvial material, contains uncoated silt and sands grains and extend more than 2.5 cm into the horizon.

(-) 3. Base saturation :

(-) 3.1. ≥15 % exchangeable Na or SAR ≥13 % in one or more horizon within 40 cm upper boundary.

(-) 3.2. Exchangeable Mg + Na > Ca + H at pH 8.2 in one or more horizon within 40 cm upper boundary if ESP ≥15 % (or SAR ≥ 13 %) in one or more horizon within 200 cm of the mineral soil surface.

SOMBRIC Horizon

Concept : Subsurface horizon with illuvial humus (different from spodic horizon) formed in cool moist soils of high plateus and mountain in (sub) tropical regions.

Properties (simplified) :

(+) 1. Position : not below an albic horizon, may form in an argillic, cambic, or oxic horizon.

(+) 2. Base saturation : V< 50 % (NH_4A_c).

(+) 3. Color : lower value and/or chroma than the overlying horizon.

(+) 4. Organic matter : mostly higher content than overlying horizon.

SPODIC Horizon

Concept : The spodic horizon is one in which active amorphous material (organic matter, alluminium, iron) have precipitated. The term "active" is used here to describe material having high exchange capacity., large surface area, and high water retention.

Genesis : - Climate : humid, mostly cold or temperate, sometimes hot.

Vegetation : heath (Calluna, Erica), Forest, sometimes savanna, palms.

Materials : sandy acid, sometimes finer.

Hidryc regime : well-drained soil or with fluctuating groundwater level.

Time : a few hundred years.

Acumulation of organic material, iron, aluminium with a maximum in the upper few cm.

Mechanism : the soluble organic compounds pick up the sesquioxsides and form chelates, which are soluble when the concentration of sesquioxsides is low and precipitate when this concentration reaches a critical level. The sesquioxsides may also precipitate by hydrolisys of the chelate induced by changes in pH or by biological destruction of organic ligands.

Other possibilities : mutual flocculation of sesquioxides (+ colloids) and humus (- colloids); flocculation by changes in redox potential or a pH.

Morphology :

- Texture : commonly sandy.
- Upper boundary : abrupt
- Colors :

  Upper part : reddest hue, lowest values, highest chromas

  Lower part or underlying hor. : yellower hues, lower chromas

  Hues : mostly redder than 10 YR

  Values/chromas (moist) : 5/6, 4/4, 3/2, 2/1, or these values in higher chromas
- Structure : mostly absent

- Organic pellets : 20-50 μ, dark, mainly in the upper part.
- Cutans : organic-metallic, cracked, on the sand grains
- Cementation : eventually (orstein)

Remarks :

- The spodic horizon may underlie an albic hor. (A_2),
- In (sub) tropical soils the A_2, may be thicker than 2 mm,
- The A_2 horizon may be mixed with the A_1 or B by plowing, falling trees, animals, or be absent,
- Commonly there is a second maximum of orgnic carbon in the spodic horizon, the first maximum occurring in the epipedon.

Properties (simplified) :

Spodic horizon is an illuvial layer.

(+) 1. Position : below an O, A_1,A_2, or Ap horizon if may however, meet the definition of an umbric epipedon. Sesquences :

$O - A_1 - A_2 - B$ $O - A_2 - B$ $O - B$

$Ap - A_2 - B$ $Ap - B$

(+) 2. Spodic horizon must have 85 % or more spodic material in a layer 2.5 cm or more thick that is not part of Ap horizon.

AGRIC Horizon

Concept : Illuviation horizon with significant amounts of illuvial clay and humus, formed under cultivation.

Genesis : With long-continued cultivation, the vegetation, the soil fauna, the chemical and physical properties change. A new cycle of soil formation starts. The horizons change bat the surface (ex. Anthropic epipedon) and even below the surface; thick, dark clay-humus cutans plaster the worm and root channels and the peds surfaces. Sometimes illuvial clay-humus fibers form.

Properties (simplified) :

(+) 1. Position immediately below an Ap horizon. Accumulation of clay + humus : fibers > 5 mm or cutans > 2 mm.

(+) 2. Thickness ≥10 cm, and

(-) 2.1. ≥5 % whormholes (by volume), including coating ≥2 mm and have value moist ≤4, chroma ≤2.

(-) 2.2. ≥5 % lamellae (by volume) that have thickness of ≥5 mm and have the value moist ≤4 and chroma ≤2.

PLACIC Horizon

Concept : Very thin subsurface horizon, black to dark red, very hard, cemented by Fe, Mn, iron-organic complex.

Genesis : Not well understood.

Climate : Always very humid, cold or tropical.

Vegetation : Rain-loving plants, often below upland sphagnum bogs.

Soil texture : Sand or clay.

Morphology :

- Very thin (1 – 10 mm), very hard, and dark.
- ± Parallel to the surface, wafy or involute, at < 50 cm.
- Single horizon, may be bifurcated.

Properties (simplified) :

(+) 1. The horizon cemented or indurated with iron or iron + manganese + organic matter, with or without other cementing.

(+) 2. Roots can penetrate only along vertical fractures with horizontal spacing ≥ 10 cm.

(+) 3. Minimum thickness 1 mm and where associated with spodic material the thickness < 25 mm.

CAMBIC Horizon

Concept : Altered, non or weakly illuvial horizon, loamy very fine sand or finer.
Formery called "structural B horizon.

Genesis :

The physical alteration is produced by:

- movement of the soil particles by frest, roots, and animal, to such extent as to destroy most of the rock structure.
- Agregation of the soil particles into peds.

The chemical alteration is produced by :

- Hydrolisys of some of the primary minerals to form clays and liberate sesquioxides (in small amounts)
- Solution and redistribution or removal of some carbonates,
- Reduction and aggregation, removal of free oxides, accompanied by biologic decomposition of inherited organic matter.

Possition :

- At the surface or below an epipedon
- Not above or below an argillic or spodic horizon

Conclution : position and alteration (without important illuviation) are essential characteristics of the cambic horizon.

Properties (simplified) :

The cambic horizon is an altered horizon ≥15 cm thick if its composed of lamellae, the combined thickness of lamellae must be ≥15 cm, and :

(+) 1. Texture : Loamy fine sand or finer in the fine earth fraction (< 2 mm)

(+) 2. Show evidence of alteration

(-) 2.1. Aquic condition within 50 cm (artificially drainage)

(+) 2.1.1. Soil structure in ≥½ of the volume.

(+) 2.1.2. Color that do not change on exposure to air.

(+) 2.1.3. Dominant color, moist on faces on peds or in matrix.

(-) 2.1.3.1. Value ≤3 and chroma 0

(-) 2.1.3.2. Value ≥4 and chroma ≤1

(-) 2.1.3.3. Any value, chroma ≤2 and redox concentration

(-) 2.2. Does not have combination of aquic condition within 50 cm (artificially drainage) and color moist as 2.1.3. and has oil structure ≥½ of the volume, and

(-) 2.2.1. Chroma, value higher, redder hue than underlying and overlying.

(-) 2.2.2. Evidence of the removal of carbonate or gypsum.

(+) 3. Has properties that do not meet requirement for anthropic, histic, folistic, melanic, mollic, plaggen, or umbric epipedon, a duripan, fragipan, argillic, calcic, gypcic, nitric, oxic, petrocalcic, petrogypcic, placic, or spodic horizon.

(+) 4. Is not part of an Ap horizon and does not have brittle manner of failure in more than 60 % of matrix.

OXIC Horizon

Concept : Subsurface horizon, highly weathered, > 30 cm thick, mixture of Fe and/or Al hydrated oxides + 1/1 clays + unweathereable minerals (quartz, zircon, etc.), very low CEC.

Genesis :

Geomorphology : Very old, stable surfaces (mid Pleistocene or older).

Stone lines common : biomantle or transported sediments.

Slope : Early level or gently sloping.

Weathering : Extreme, no rock structure in the fine earth; no weatherable minerals; no reserve of bases.

Climate : (sub) tropical, elevation < 1500 – 2000 m.

Morphology :

- May extend till great depth; for practical reasons, its lower boundary arbitrarily put at 2 m.

- Concistence, structure : massive, or weakly prismatic or blocky. High friability (granules Ø < 1 mm), and low plasticity.
- Subhorizon boundaries : diffuse (except if there is : stone line, plinthite, sheets of gibsite).
- Porocity : very high
- Rock structure : < 5 % by volume (saprolite)
- Colors : not diagnostic (gray, brown, red, mixtures).

Properties (simplified) :

(+) 1. Thickness : ≥30 cm.

(+) 2. A texture sandy loam or finer.

(+) 3. < 10 % weatherable mineral in 50 – 200 μ fine sand.

(+) 4. Rock structure < 5 %, unless lithorelicts with weatherable mineral are coated with sesquioxides.

(+) 5. A diffuse upper boundary within vertical distance of 15 cm clay increase.

(-) 5.1. < 4% if clay content < 20 %

(-) 5.2. < 20 % if clay content 20 – 40 %

(-) 5.3. < 8 % if clay content > 40 %

(+) 6. CEC ≤16 cmol.(+)/kg and ECEC clay ≤12 cmol. (+)/kg.

DURIPAN

Concept : Subsurface horizon cemented by SiO_2 (accessory by iron oxides and $CaCO_3$)

Genesis : Subhumid Mediterranean or arid (always seasonally dry). The moisture regime is suchs that silica may be washed down into but not put of the soil.

Parent material : Glass (Si) and some Ca

Situation : Areas of volcanism

Morphology :

Arid climate

- Strongly cemented, platy, 1 – 15 cm.
- $CaCO_3$: small to large amounts.
- Cementation may be destroyed by treatment with acids ($CaCO_3$), followed by treatment with concentrated hot alkali.

Mediterranean climates

- Weakly cemented,"brittle" when moist,very hard when dry.
- Prisms or polyhedrons : Ø ⅓ - 3 m or more.
- $CaCO_3$: weak or absent.

Properties (simplified) :

(+) 1. The pan is cemented or indurated in more 50 % of the volume of some horizon.

(+) 2. The pan show evidence of the accumulation of opal or other form of silica, such as laminar caps, coatings, lenses, partly filled interstices, bridge, between sand sized grains, or coating on rock or pararock fragment.

(+) 3. Less than 50 % of the volume at air dry fragment slakes in 1 N HCl but > 50 % slakes in concentrate KOH or NaOH or in alterating acid and alkali.

(+) 4. Root can penetrating the pan along vertical feature with horizontal spacing of 10 cm or more.

FRAGIPAN

Concept : Loamy subsurface horizon, often underlying a cambic, spodic, argillic or albic horizon. High bulk density, very hard when dry, weakly brittle when moist; usually mottled. Thick platty structure; polygonal network with bleached cracks (root).

Genesis : Has been attribute to : weight or glaciers, permafrost, other (peri) glacial phenomena,. American authors consider the fragipan as a soil horizon.

Properties (simplified) :

(+) 1. The layer is ≥15 cm.

(+) 2. The layer show evidence of pedogenesis, within the horizon or at minimum on the faces of structural unit.

(+) 3. Structure very coarse prismatic, columnar or blocky of any grade, has weak structure of any size, or is massive. Separation between structural units that allow roots to enter, have average spacing ≥10 cm (horizontal dimensions).

(+) 4. Air dry fragments of natural soil fabric, 5 – 10 cm diameter, from more than 50 % of the horizon slake when they are submerged in water.

(+) 5. The layer has in 60 % or more of the volume, a firm or firmer rupture – resistence class, brittle manner of failure at near field capacity air virtually no roots.

(+) 6. The layer is not effervecent (indilute HCl).

ALBIC Horizon

Concept : Strongly leached A_2 horizon.

Genesis : Removal of clay and/or free iron oxides in soils with an argillic or spodic horizon.

Morphology :

- Light colors.
- Structure : absent or weakly platty

Properties (simplified) :

(+) 1. Elluviation of clay and/or free iron oxides

(+) 2. Position :

(-) 2.1. Above an argillic (A_2 – Bt) or a spodic horizon (A_2 – Bh/ir)

(-) 2.2. Between a spodic and an argillic horizon (Bh/ir – A'_2 – B't)

(-) 2.3. Between an argillic horizon and fragipan (Bt - A'_2 – fragipan)

(-) 2.4. Between a cambic and an argillic or natric horizon (B - A'_2 – B't or fragipan (B - A'_2 – fragipan)

CALCIC Horizon

Concept : Horizon of accumulation of $CaCO_3$ and/or $MgCO_3$.

Genesis : Carbonates accumulate in the C horizon, but may also affect the mollic epipedon, the argillic or natric horizon and the duripan. They precipitate as : powder, pendants or pebbles.

Arid region :

On calcareous materials : often the only horizon that can develop is the calcic, at shallow depth.

Semi – arid region :

The calcic horizon may form above or in an argillic horizon, the carbonates are received from eolian sources.

Soil with groundwater :

When the water contains $Ca(HCO_3)_2$, the evaporation may cause precipitation of $CaCO_3$, at the surface or at shallow depth (30 – 60 cm), the surface calcic horizon may at the same time be a mollic epipedon.

Properties (simplified) :

Underlying materials have < CO_3 than the calcic horizon

(+) 1. Thickness : ≥15 cm.

(+) 2. Not indurated and not meet requirements of petrocalcic horizon.

(+) 3. Has one or more :

- (-) 3.1. ≥15 % $CaCO_3$ equivalent and ≥5 % more than underlying horizon
- (-) 3.2. ≥15 % $CaCO_3$ equivalent, ≥5 % secondary carbonate (by volume)
- (-) 3.3. ≥5 % $CaCO_3$ equivalent and
  - (+) 3.3.1. < 18 % clay in the fine earth fraction
  - (+) 3.3.2. A sandy, sandy skeletal, coarse loamy or loamy skeletal particle class and
  - (+) 3.3.3. ≥5 % by volume identifiable secondary carbonate or carbonate equivalent 5 % than underlying horizon.

PETROCALCIC Horizon

Concept : Calcic horizon continuously cemented or indurated by $CaCO_3$ $MgCO_3$ (accessory silica).

Genesis : Regular and important additions of carbonate plug the calcic horiz old surface.

Properties (simplified):

(+) 1. Continuously cemented or indurated calcic horizon by carbonate.

(+) 2. Root can penetrate along vertical fracture with horizontal spacing ≥10 cm

(+) 3. Thickness

(-) 3.1. Thickness ≥10 cm.

(-) 3.2. ≥1 cm if consist of laminar cap directly underlying by bedrock.

GYPSIC Horizon

Concept : Horizon of secondary gypsum enrichment

Properties (simplified) :

(+) 1. Thickness ≥15 cm.

(+) 2. Is not cemented or indurated to such a degree that it meets the requireme for petrogypsic horizon.

(+) 3. ≥5 % more than the underlying layer or ≥1 % (by volume) seconda visible gypsum.

(+) 4. cm (thickness) x % gypsum ≥150

Remarks : % gypsum = m.eq gypsum/100 g soil x 0,086.

PETROGYPSIC Horizon

Concept : Cemented or indurated gypsic horizon

Genesis : Arid climate, parent material rich in gypsum

Properties (simplified) :

(+) 1. Indurated by gypsum

(+) 2. Root can penetrate only along vertical fracture with horizontal spacing ≥10 cm

(+) 3. Thickness ≥10 cm

(+) 4. ≥5 % gypsum, and the product multiplied by thicknes is ≥150 cm.

SALLIC Horizon :

Concept : Horizon with secondary enrichment of salt more soluble in cold water than gypsum.

Properties (simplified) :

(+) 1. Thicknes ≥15 cm and has ≥90 consecutive days in normal years.

(+) 2. EC ≥30 d S/m in saturated part.

(+) 3. A product E.C with thicknes is ≥900

SULFURIC Horizon

Concept : Mineral organic soil material with jarosite, with very low pH (cat-clay)

Genesis : Cat-clay formation (acid sulfate soils)

Properties (simplified) :

(+) 1. pH (1 : 1 water) : 3.5.

(+) 2. Jarosite mottles (hue 2.5 Y or yellower, chroma > 6) $KFe_3(SO_4)_2(OH)_6$

GLOSSIC Horizon

Concept : The glossic horizon develops as a result of the degradation of an argillic, a kandic, or a natric horizon, from which clay and free iron oxides are removed. This process of elluviation gradually progesses from ther exteriors of peds to their interiors.

Genesis : A glossic horizon usually occurs between an overlying albic horizon, and an underlying argillic, kandic, or natric, or fragipan.

Properties (simplified) :

The glossic horizon is ≥5 cm thick and consist of :

(+) 1. An elluvial part, i.e., albic materials, which constitute 15 – 85 % (by volume) of the glossic horizon.

(+) 2. An illuvial part, i.e., remants an argillic, kandic, or natric horizon.

KANDIC Horizon

Properties (simplified) :

(+) 1. Underlies a coarser – textured surface horizon, is 18 cm after mixing, or 5 cm if the textural transition to the kandic horizon is abrupt and there is no (para) lithic, or petroferic contact within 50 cm.

(+) 2. Has its upper boundary :

(+) 2.1. Clay percentage in the fine earth fraction, increasing with depth within a vertical distance ≤15 cm :

	% clay in A	% clay in B	Vert. distance
(-) 2.1.1.	< 20 %	≥% A + 4 %	≤15 cm
(-) 2.1.2.	20 – 40 %	≥% A + 20 %	≤15 cm
(-) 2.1.3.	> 40 %	≥% A + 8 %	≤15 cm

(+) 2.2. At a depth

(-) 2.2.1. 100 – 200 cm, if the particle – size class throughout the upper 100 cm is sandy.

(-) 2.2.2. Within 100 cm of the surface horizon if the clay content in fine earth fraction of the surface horizon is ≥20 %.

(-) 2.2.3. Within 125 cm from the mineral soil surface for all other soil.

(+) 3. Thickness :

(-) 3.1. ≥30 cm.

(-) 3.2. ≥15 cm if there is a (para) lithic, or petroferric contact ≤50 cm and the kandic horion constitute ≥60 % of the vertical distance between a depth 18 cm and the contact.

(+) 4. Textured : Loamy very fine sand or finer.

(+) 5. CEC ≤16 cmol (+)/kg clay (NH_4OAC pH 7) and an ECEC ≤12 cmol (+)/kg clay (NH_4OAC + KCL extractable Al)

(+) 6. Has a regular decrease in organic carbon content with increasing depth, no fine stratification.

3. OTHER DIAGNOSTIC SOIL CHARACTERISTICS

ABRUPT TEXTURAL CHANGE

Overdeveloped argillic or natric horizon :

	% clay in A Ochric Albic	% clay in B	vertical distance
(-) 1.	< 20	(+) > 2 x %A	< 7.5 cm
(-) 2.	> 20	(+) 2.1. > %A + 20%	< 7.5 cm
		(+) 2.2. 2 x %A in some part	

ALBIC Material

Albic material are soil material with a color that is largely determined by the color of primary sand and silt particles, rather than by the color of their coatings.

Properties (simplified) :

(-) 1. A chroma ≤2

(-) 1.1. A color value ≥3 (moist), and a color value ≥6 (dry)

(-) 1.2. A color value ≥4 (moist), and a color value ≥5 (dry)

(-) 2. A chroma ≤3

(-) 2.1. A color value ≥6 (moist)

(-) 2.2. A color value ≥7 (dry)

(-) 3. A chroma that is controlled by the color of uncoated grains of silt or sand, hue of 5 YR or redder, and color values listed in 1.1 or 1.2 above.

ANDIC Soil Properties

Concept : Andic soil properties result mainly from the presence, in solis c significant amounts of allophane, imogolite, ferrihydrite or aluminiur humus complexes. Most horizon that have andic soil propertie consist of mineral, soil material but some consist of organic so materials but they must have < 25 % organic carbon.

Properties (simplified)

(-) 1. In the fine earth fraction, all of the following :

(+) 1.1. Al + ½ % Fe (by ammonium oxalate) totaling ≥2 %

(+) 1.2. BV measured at pF 2.54 ≤0.9 g/cm^3.

(+) 1.3. A phosphate retention ≥85 %.

(-) 2. In the fine earth fraction, A phosphate retention ≥25 %, ≥30 % particles c 0.02 – 2.0 mm, and all of the following :

(+) 2.1. Al + ½ % Fe (by ammonium oxalate) totaling ≥ 0.4 and in the 0.02 – 2.0 mm.

(+) 2.2. ≥ 5 % volcanic glass.

(+) 2.3. [(Al + ½ % Fe ammonium oxalate) times (15.625)] + [glass content, %] ≥ 36.25. The shaded area of figure 1. illustrated criteria 2.1, 2.2, and 2.3.

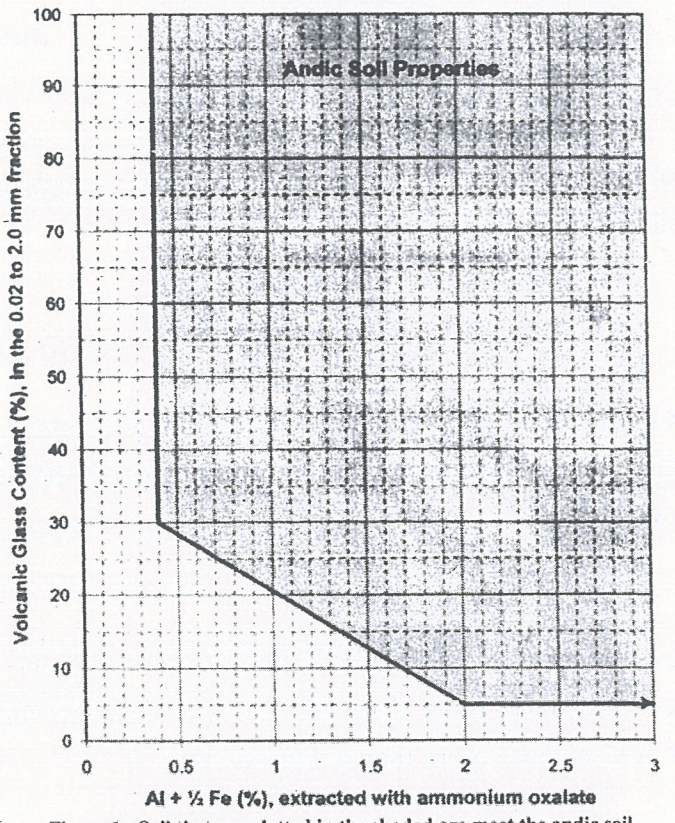


Figure 1. -Soil that are plotted in the shaded are meet the andic soil properties criteria a, b, and c under item 2 of the required characteristics. To qualify as soil with andic properties, the soils must also meet the listed requirements for organic-carbon content, phosphate retention, and particle-size distribution.

COLE (Coefficient Of Linear Extensibility)

Ratio of the different between the moist (1/3 bar) and dry (15 bar) lengths of a clod to its dry length :

$$COLE = \frac{Lm - Ld}{Ld}$$

DURINODES

Nodules cemented by SiO_2, $\emptyset \geq 1$ cm

GILGAI

Microrelief of clayey soils (2/1) in nearly level areas : micro-basins or micro-valleys and mikro-ridges.

DRY

Soil moisture content below permanent wilting point (>15 bar).

Usually Dry : dry more than half the time that the soil not frozen, the period of dryness being nearly continous.

MOIST

Soil moisture content above permanent wilting point (< 15 bar).

Usually moist : moist for more than half the time that the soil is not frozen (contiuous or in periods of more than a few weeks).

LITHIC Contact

Boundary between soil and continuous, coherent, hard bedrock.

PARALITHIC Contact

Idem as lithic, but less hard.

PETROFERRIC Contact

Boundary between soil and continuous layer of indurated material in which Fe is an important cement (> 30 % Fe2O3). Mostly indurated laterite.

PLINTHITE

Sesquioxides rich, humus poor, mixture of clay with quartz and other diluents, which commonly occurs as red mottles, usually in platy, polygonal or reticulate patterns.

Non indurated, but irreversible hardened (hardpan, ironstone) by repeated wetting and drying or exposure to the sun.

Can form a discontinuous or a continuous phase in the soil.

n VALUE

$$n = \frac{A - 0.2\,R}{L + 3H}$$

A = % water in soil in field condition, calculated on a dry soil basis

R = % silt + sand (R = 100 – L – H)

L = % clay (L = 100 – R – H)

H = % organic matter (= % organic carbon x 1.724)

The higher n, the lower the bearing capacity.

Critical value of n = 0.7 (> 0.7 : unripe layer)

PERMAFROST

Layer with temperature permanently < 0° C.

SLICKENSIDES

Polished grooved surfaces produced by one mass sliding past another

: 1 calys.

ORGANIC Soil Materials

(-) 1. Litter, O horizon

Never saturaterd with weater for more than a few days, and having > 20 % organic carbon (by weight)

(-) 2. Peats, mucks

Saturated with water for along periods (unless artificially drained) and having

(-) 2.1. > 18 % organic carbon mineral fraction has > 60 % clay.

(-) 2.2. > 12 % organic carbon if the mineral fraction has 0 % clay.

(-) 2.3. Proportional intermediate organic carbon (> 12 % - > 18 %) if the clay % is intermediate (0 % - 60 %).

MOTTLES

Mottled : marked with spots of contrasting colors in a horizon saturated with water at some season of the year (unless artifially drained).

PARTICLES – SIZE Classes

Texture : grain-size distribution of the fine earth fraction (<2 mm)

Particle-size class : Based on fine earth (< 2 mm) + coarse fragment (> 2 mm)

Pragmental : Stones, cobles, gravel and very coarser sand particles, fines (< 2 mm) too few ti fill interstices > 1 mm.

Sandy : < 35 % (volume) of coarse fragment > 2 mm; texture of the fine earth : sand or loamy sand, coarser than very fine sand and loamy fine sand (very fine sand : 50 μ – 100 μ).

Sandy-skeletal : > 35 % (volume) of coarse fragments > 2 mm; textures of the fine earth : see sandy.

Clayey : >35 % (volume) of coarse fragments > 2 mm, fine earth : 35 % (weight) clay.

Clayey-skeletal : > 35 % (volume) of coarse fragments; textures of the fine earth : see clayey.

Loamy : All other classes having < 35 %(volume) of coarse fragments > 2 mm.

Loamy-skeletal : > 35 % (volume) of coarse fragments; textures of the fine earth : see loamy.

SULFIDIC Materials

Waterlogged materials having :

(+) 1. > 0.75 % S (dry-weight), mostly sulfides;

(+) 2. % S > 3 x % carbonates ($CaCO_3$ equivalent)

Sulfidic materials → sulfuric horizon

Dried slowly (2 months) → pH very acid

Field test : boiling in concentration H_2O_2 → pH drop

THIXOTROPY

Reversible gel-sol transformation

TONGUING-INTERFINGERING

Penetration of bleached materials or of an albic horizon into an argillic or natric horizon along ped surfaces.

WEATHERABLE MINERALS

Clay minerals = 2 : 1 (except ; Al interlayered chlorite)

Feldspar

Feldsparthoids

Ferromagnesian mineral

Glass

Micas

Zeolites

SOFT POWDERY LIME

(+) 1. Translocated authigenic CaCO3, that has been precipitated,

(+) 2. Cutans > 1 mm or "white eyes" (bjeloglaska),

(+) 3. Softer than fingernail

Remarks : pseudomicelium is not include here.

SOIL TEMPERATURE Regimes (simplified)

ST : Soil Temperature (at 50 cm depth or at a (para) lithic contact < 50 cm).

MAST : Mean Annual Soil Temperature.

MSST : Mean Summer Soil Temperature (at 50 cm depth, etc.)

MWST : Mean Winter Soil Temperature (at 50 cm depth, etc.)

(-) 1. In Mineral Soils

(-) 1.1. If the soil is not saturated with water during some part of th summer

(+) 1.1.1. No O horizon < 15° C

(+) 1.1.2. With O horizon < 8° C

(-) 1.2. If the soil saturated with water during some part of the summer

(+) 1.2.1. No O horizon < 13° C

(+) 1.2.2. With O horizon or histic epipedon < 6° C

(-) 2. If organic soil MAST < 6° C

	MAST	MSST – MWST	MSST
Pergelic	< 0° C		
Cryic	< 8° C no permafrost		Low
Frigid	< 8° C	> 6° C	> cryic
Isofrigid	< 8° C		
Boreal	< 8° C		
Mesic	≥8 - < 15° C	> 6° C	
Isomesic	≥8 - < 15° C		
Thermic	≥15 - < 22° C	> 6° C	
Isothermic	≥15 - < 22° C		
Hyperthermic	≥22° C	> 6° C	
Isohyperthermic	≥22° C		

Mean Annual Soil Temperature

It is essentially the same in all horizon at all depth in the soil and at depth considerably below the soil. It is closely related to mean annual soil temperature.

Fluctuation of soil temperature

Fluctuation occur as daily and annual cycles. They decrease with depth, at great depth the temperature is constant and the same as the MAST.

Daily changes have a significant effect to a depth of about 50 cm. Moisture reduces fluctuation at the surface.

- Seasonal fluctuation in the tropics : are generally small in intertropical regions (between the tropics of Capricon and Cancer). MSST – MWST < 5 ° C.
- Seasonal fluctuation and gradients in mid latitudes : are marked; at 10 – 20 m depth the soil temperature is constant and = MAST. In the presence of groundwater constant soil temperature is reached at 9 m. MSST – MWST > 5° C.
- Seasonal fluctuation in high latitude : cold soil, summer soil temperature are appreciably lower than the air temperatures.

Measurement of soil temperature

In the USA : MAST = Mean Annual Air Temperature + 1° C.

MSST (upper in) = Mean Summer Air Temperature – 0.6° C.

Direct measurement by a single reading :

- At a depth of 13 m : MAST
- At a depth of 10 m : MAST, error 0.1° C.

Measurement of temperature of well water between 9 – 18 m = MAST (the well must be in uise). Error < 1° C.

Four readings at 50 cm depth in the soil, equally spaced, give the MAST. Error 0.3° C.

Measurement at 15 th of June, July, August at 50 cm = MSST. Error 0.6° C.

SOIL MOISTURE Regime (simplified)

The soil moisture regime as used here refers to the presence in the control section of :

- Groundwater,
- Water held at tension < 15 bar by periods of the year.

Soil moisture control section (simplified)

- Fine loamy, silty,clayey : 10 – 30 cm,
- Coarse loamy : 20 – 60 cm,
- Sandy : 30 – 90 cm.

Remaks :

1 mm water : 11 water/m^2 (1000000 mm^3/100000 mm^2)

1 % volume water = 1mm^3 water/100 mm^3 soil = 1 mm water/10 cm soil

1 % volume water = 11 water/m^2 x 10 cm soil.

Aquic moisture regime

Mostly reduced regime due to saturation by groundwater or its capillary fringe (sands : 10 – 15 cm; loams, calys : > 30 cm) at < 50 cm.

Duration : At least a few days, the soil temperature being > 5° C.

Aquic : Groundwater level fluctuates

Peraquic : Groundwater level always very close or at the surface.

Aridic or torric moisture regime

Arid and some semi-arid regions : No leaching, accumulation of soluble salts.

Udic moisture regime

Udic : Water moves through the soil at some time during the year in most years.

Perudic : Water moves through the soil all month of most years.

Ustic moisture regime

Intermediate between aridic and udic.

Tropical subtropical regions with 1 or 2 dry seasons : monsoon climate with at least 1 rainly season of > 3 months.

Temperate regions : subhumid or semi-arid climate, rainly season in spring + summer + fall, never in winter.

Xeric moisture regime

Mediterranean climate : moist cool winters, dry warm summers.

Moisture Regime	Years	Dryness Days Cumul./Consec.	Moistness Days Cumul./Consec.	Soil Temperature	
				MAST	MSST - MWST
Aquic	10/10		Saturated > few days		
Aridic/Torric	> 5/10	> 180	< 180 < 90		
Udic 1.	> 5/10	< 90	> 270		
2.	> 6/10	< 90 < 45 s	> 270	< 22°C	> 5°C
Ustic 1.	> 5/10	< 90	> 180 > 90	> 22°C	< 5°C
2.	> 6/10	< 90 < 45 s	> 180 > 45 w	< 22°C	> 5°C
Xeric	> 6/10	> 45 s	> 180 > 45 w	< 22°C	> 5°C

s : Summer

w : Winter

THE CATEGORIES SYSTEM

Nomenclature

1. Order
2. Suborder
3. Great group
4. Subgroup
5. Family
6. Series

1. THE ORDERS

Number : 12

Criteria : ± Climatic group of soil, that differ little in the kinds and relative strength of processes tending to develop horizons.

Nomenclature : root (1 – 2 syll) + i/o + sol = 3 – 4 syll.

The root contains the formative element (2 – 3 letters)

1. Entisols

Soils without distinct pedogenesis horizons. No diagnostic horizons, except the ochric or albic and those that are produced through cultivation by man.

Approximate equivalent : Alluvial soils, skeletal soils, Lithosols, Regosols.

2. Vertisols

Soils with > 30 % 2 : 1 clays (cracks, gilgai, slickensides)

Approximate equivalent : Black tropical clays, regurs, Tirs, Smolnitza, etc.

3. **Inceptisols**

Soils with diagnostic horizons that form quickly without significant eluviation or illuviation, and without extreme weathering.

Approximate equivalent : Sols Burn Acides, Brown Forest soils, Low-humic Gley soils, Humic Gley soils.

4. **Andisols**

Soils with diagnostic horizon that form quickly without significant elluviation or illuviation, and without extreme weathering.

Approximate equivalent : Ando soils

5. **Aridisols**

Soils of dry places with diagnostic horizons.

Approximate equivalent : Desert soils, Reddish soils desert soils, Sierozem, Solonchacks, Brown soils, Solonetz.

6. **Mollisols**

Soils with mollic epipedon, mostly developed under a grass vegetation.

Approximate equivalent : Chestnut soils, Chernozems, Brunizems (Prairie soils), Rendzinas, Brown Forest soils, Solonetz, Humic Gley soils.

7. **Spodosols**

Soils with a spodic horizon.

Approximate equivalent : Podzols, Brown Podzolic soils, Groundwater Podzols.

8. **Alfisols**

Soils with an argillic horizon or natric horizon and V > 35 %

Approximate equivalent : Gray-Brown Podzolic soils, Gray Wooded soils, Non calcic Brown soils, Degraded Chernozems, Planosols.

9. **Ultisols**

Soils with an argillic horizon V < 35 %.

Approximate equivalent : Red and Yellow Podzolic soils, Reddish Brow Lateritic soils, and associated Planosols.

10. **Oxisols**

Soils with an oxic horizon.

Approximate equivalent : Lateritic soils, Latosols.

11. **Histosols**

Organic soils.

Approximate equivalent : Bog soils.

12. **Gelisols**

Soils that have permafrost.

2. THE SUBORDERS

Number : 4 – 7 per order. Total : 60.

Criteria :

1. Presence or absence of waterlogging.
2. Genetic differences due to climate and vegetation.
3. Extremes textures (sands), dominance af allophane off free sesquioxides the fraction < 2 μ.

Nomenclature : Prefixc + formative element of the order = 2 syll.

Examples : Orth + od = Orthod

Aqu + oll = Aquoll

Arg + id = Argid

3. THE GREAT GROUPS

Number : 1 – 10 per suborder. Total : 299

Criteria :

1. Diagnostic horizons indicating both major differences in degree of development and minor differences in kind : Bt, Bh, Bir, thick A; pans; anthtropic horizon.
2. Diagnostic properties : dark red and dark brown colors (basic rocks), V, irreversible hardening, tonguing of A2, low soil temperatures.

Nomenclature : Prefix (+ i) + suborder = 3 – 4 syll.

Examples : Hapl + orthod = Haplorthod

Dur + aquoll = Duraquoll

Arg + boroll = Argiboroll

4. THE SUBGROUPS

Number : A few thousands

Nomenclature : adjective (s) + great group.

Kinds :

1. Central concept of the great group : typic Hapludalf
2. Intergrades : transitions to other great group of
   - 2.1. The some suborder : Argic Hapludalf
   - 2.2. An other suborder of the same order : Aquic Hapludalf
   - 2.3. An other order : Mollic Hapludalf
3. Extragrades : transitions to non-soil or not existing soils :
   Lithic Hapludalf
   Cumullic Hapludoll
4. Multiple Intergrades : Nariboric-mollic Hapludalf.

5. THE FAMILIES

Criteria : Properties important to the growth of plant (texture, mineralogy, pH, soil temperature, permeability, thickness, consistence, moisture equivalent, slope).

6. THE SERIES

Criteria : Minor differences in texture, mineralogy, thickness of horizon, etc.

KEY TO SOIL ORDERS (simplified)

Soils that have :

(-) 1. Permafrost within 100 cm of the soil surface.

(-) 2. Gelic material within 100 cm and permafrost within 200 cm of the soil surface.

12. Gelisols

Other soils that have :

(+) 1. Organic soils as definition of organic soils

11. Histosols

Other soils that have :

(+) 1. No plaggen epipedon, argillic or kandic horizon above spodic horizon.

(-) 2. A spodic horizon, an albic horizon ≥50 % of pedon and cryic regime.

(-) 3. An Ap horizon, spodic materials ≥85 %

(-) 4. Spodic horizon have all the following

(+) 4.1. One or more :

(-) 4.1.1. Thickness ≥10 cm.

(-) 4.1.2. An overlying Ap horizon

(-) 4.1.3. Cementation ≥50 %

(-) 4.1.4. A coarse loamy, loamy skeletal, or finer particle size class and rigid regime

(-) 4.1.5. Cryic regime

(+) 4.2. An upper boundary

(-) 4.2.1. < 50 cm

(-) 4.2.2. < 200 cm if the soil has sandy particle size class at least some particle till spodic.

(+) 4.3. A lower boundary

(-) 4.3.1. ≥25 cm or at the top of duripan, densic, and lithic.

(-) 4.3.2. At any depth

(-) 4.3.2.1. If the spodic has a coarse loamy, loamy skeletal, or finer class and frigid regime.

(-) 4.3.2.2. Cryic regime

(+) 4.4. Either

(-) 4.4.1. A directly overlying albic horizon ≥50 %

(-) 4.4.2. No andic soil properties ≥60 % of the thickness

(-) 4.4.2.1. Within 60 cm either of mineral soil surface or of the top an organic layer with andic soil properties, if whichever shallower, if there is no densic etc.

(-) 4.4.2.2. Between either the mineral soil surface or at the top of an organic layer with andic soil properties, whichever shallower, if there is no densic etc.

7. Spodosols

Other soils that have :

(+) 1. ≥60 % of the thickness, andic soil properties

(-) 2. Within 60 cm either of the mineral soil surface, or of the top of an organic layer with andic oil properties, whichever is shallower, if no (para) lithic contact, duripan, or petrocalcic horizon.

(-) 3. Between either of the mineral surface, or the top of organic layer with andic soil properties, whichever is shallower, and (para) lithic contact, duripan, or petrocalcic horizon.

4. Andisols

Other soils that have :

(+) 1. An oxic horizon, its upper boundary within 150 cm, and no kandic horizon.

(-) 2. Mineral soils surface 18 cm after mixing, ≥40 % clay in fine earth fraction, and a kandic horizon with weatherable mineral properties, of an oxic, upper boundary within 100 cm.

10. Oxisols

Other soils that have :

(+) 1. ≥30 % at 18 – 50 cm or densic etc. it shallower. A layer ≥25 cm, with upper boundary within 100 cm that has slickenside or wedge-shaped peds, that have their long axes tilted 10-60 degrees.

(+) 2. Weighted average ≥30 % clay till 18 cm or in Ap horizon whichever is thicker, and ≥30 % at 18-50 cm or densic etc. it shallower.

(+) 3. Their long axes tilted 10-60 degrees. Cracks that open and close periodically.

2. Vertisols

Other soil that have:

(-) 1. Have

- (+) 1.1. Aridic soil moisture regime.
- (+) 1.2. Ochric or anthropic epipedon.
- (+) 1.3. One or more : with upper boundary within 100 cm, a cambic horizon with lower depth ≥25 cm; cryic temperature regime and cambic horizon; calcic,gypsic, petrocalcic, petrogypcic, salic, or duripan.
- (-) 1.4. An argillic or natric horizon.

(-) 2. Have salic horizon

- (+) 2.1. Saturation with water ≥1 layer within 100 cm for one month or more in normal years.
- (+) 2.2. A moisture control section that is dry in some or all parts in normal years.

(+) 2.3. No sulfuric horizon within 150 cm.

5. Aridisols

Other soils that have

(-) 1. An argillic or kandic horizon and V < 35 %

(-) 1.1. If the epipedon has sandy or sandy-skeletal particle size

(-) 1.1.1. 125 cm bellow upper boundary of argillic but no deepe than 200 cm or 180 cm bellow the mineral soil surface

(-) 1.1.2. At a densic, lithic etc. if shallower.

(-) 1.2. The shallowest of the following depth

(-) 1.2.1. 125 cm below the upper boundary of the argillic kandic horizon.

(-) 1.2.2. 180 cm below te mineral soil surface.

(-) 1.2.3. At a densic, (para) lithic, or petroferric contact.

(-) 2. A fragipan and both

(+) 2.1. Either an argillic or kandic horizon above, within or below it clay films ≥1 mm thick, in one or more of it subhorizon.

(+) 2.2. V < 35 % at the shallowest of the following depth.

(-) 2.2.1. 75 cm below the upper boundary of fragipan.

(-) 2.2.2. 200 cm below the the mineral soil surface.

(-) 2.2.3. At densic, (para) lithic, or petroferric contact.

9. Ultisols

Other soils that have :

(+) 1. Either

(-) 1.1. A mollic epipedon.

(-) 1.2. Both a surface horizon as mollic except thickness 18 cm af mixed and a subhorizon > 7.5 cm thick, within the upper part argillic, kandic, natric as mollic requirement but separated albic horizon.

(+) 2. V ≥50 % in all horizon

(-) 2.1. Between upper boundary of any argillic, kandic, or natric till 125 cm

(-) 2.2. Between mineral soil surface till 180 cm or shallower

6. Mollisols

Other soils that have :

No plaggen epipedon

(-) 1. An argillic, kandic, or natric horizon

(-) 2. A fragipan that has clay films 1 mm or more thick in some parts

8. Alfisols

Other soils that have :

(-) 1. One or more

(+) 1.1. A cambic horizon with upper boundary within 100 cm and lower boundary at depth 25 cm or more below the mineral soil surface.

(+) 1.2. A calcic, petrocalcic, placic horizon, duripan or fragipan with an upper boundary within 100 cm

(+) 1.3. A fragipan or an oxic, sombric, or spodic horizon with upper boundary within 200 cm

(+) 1.4. A sulfuric horizon with upper boundary within 150 cm

(+) 1.5. A cryic temperature regime and cambic

(-) 2. No sulfidic material within 50 cm and both

(+) 2.1. n value ≤0.7 in one or more horizon between 20-50 cm or < 8 % clay.

(+) 2.2. One or both

(-) 2.2.1. Salic or histic, mollic, plaggen or umbric

(-) 2.2.2. In ≥50 % of the the layers till 50 cm depth ESP ≥15 (SAR ≥ 13) which decreases with increasing depth below 50 cm and also ground water within 100 cm when soil is not frozen.

3. Inceptisols

Other soils

1. Entisols

ENTISOL

Central concept

Soils that have little or no evidence of development of pedogenic horizon.

Genesis : Reasons for absence of profile development are :

- Shortness of time,
- Dryness : little amount of water movement in the soil,
- Wetness : permanent saturation with water or subemergence,
- Erosion : pedogenic horizon can not form,
- Sedimentation : the soil is always "renewed",
- Drastic change of the original profile by man,
- Exceptional resistance to weathering,
- Toxicity of initial materials.

Extension : ± 20 % of the world (mountains, deserts, sands, alluvia)

Diagnostic horizon :

(-) 1. Ochric epipedon

(-) 2. Albic horizon, histic epipedon, anthropic epipedon, buried horizon.

(-) 3. None

moisture and temperature regime : any

parent material, vegetation, age : any

Definition : entisols are mineral soils that have :

(-) 1. Sulfidic material at < 50 cm

(-) 2. n value > 0.7 at < 50 cm

(-) 3. Ochric epipedon, (histic epipedon, albic horizon, spodic horizon at > 2 m, buried horizon at > 50 cm)

(+) 4. No other diagnostic horizon or properties.

KEY TO SUBORDER OF ENTISOLS

(-) Entisols having

(-) 1. Aquic condition and sulfidic materials at < 50 cm

(-) 2. Saturated with water permanently : blue or gray at > 25 cm in layer above a densic, or (para) lithic contact

(-) 3. Or in 40-50 cm whichever is shallower that have, in one or more layers

(-) 3.1. ≥50 % of the matrix a texture finer than loamy fine sand

(-) 3.1.1. Chroma of 0

(-) 3.1.2. Chroma ≤1 and color value moist ≥4

(-) 3.1.3. Chroma ≤2 and redox concentration

(-) 3.2. ≥50 % of the matrix a texture of loamy fine sand or coarser

(-) 3.2.1. Chroma of 0

(-) 3.2.2. Hue of 10 YR or redder

(-) 3.2.3. Hue of 10 YR or redder, chroma ≤2, and redox concentration

(-) 3.2.4. Hue of 2.5 Y or yellower, chroma ≤3, and distinct redox concentration

(-) 3.2.5. Hue of 2.5 Y or yellower and chroma 1

(-) 3.2.6. Hue of 5 GY, 5 G, 5 BG, or 5 B

(-) 3.2.7. Any color if it result from uncoated sand grains

(-) 3.3. Enough active ferrous iron, positif with αα-dipyridy during not irrigated.

Aquents

(-) Other Entisols that have, in one or more layers having fragment ≥3 % b volume of diagnostic horizon at 25 – 100 cm

Arents

(-) Other Entisols having < 35 % (by volume) rock fragments and textures of loamy fine sand or coarser

Psamments

(-) Other Entisols that do not have densic, or (para) lithic contact within 25 cm

(+) 1. A slope < 25 %

(+) 2. Either ≥0.2 % organic carbon of holocene age at depth 125 cm or regular decrease organic carbon at 25 – 125 cm or to densic, or (para) lithic contact if shallower.

(+) 3. A soil temperature regime

(-) 3.1. Warmer than cryic

(-) 3.2. Cryic and the soil has

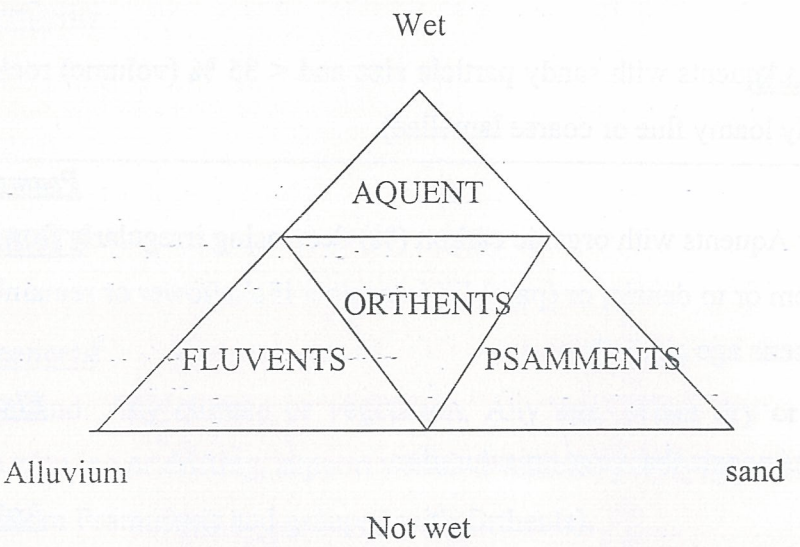
(-) 3.2.1. No gelic material

(-) 3.2.2. Either slope < 5 % or < 15 % volcanic glass in 0.02 – 2.0 mm fraction in some part.

Fluvents

(-) Other Entisols

Orthents



SUBORDERS AND GREAT GROUP OF ENTISOLS

AQUENTS

Central concept

Wet entisols : Tidal marshes, deltas, margins of lakes, floodplains of streams.

Blueish or gray mottled temperature regime : any but not pergelic.

Moisture regime : (per) aquic. Recent sediments. Any vegetation that tolerate permanent or periodic wetness.

Definition : see key of suborders.

Greatgroup

(-) Aquents with sulfidic material at < 50 cm.

Sulfaquents

(-) Other Aquents with

(+) 1. n value > 0.7

(+) 2. > 8 % clay between 20 – 50 cm

Hidraquents

(-) Other Aquents with cryic regime.

Cryaquents

(-) Other Aquents with sandy particle size and < 35 % (volume) rock fragmen (sandy loamy fine or coarse lamellae).

Psammaquents

(-) Other Aquents with organic carbon (%) decreasing irregularly from depth 25 125 cm or to densic, or (para) lithic contact if shallower or remaining ≥0.2 holocene age at depth.

Fluvaquents

(-) Other Aquents that have episaturation.

Epiaquents

(-) Other Aquents

Endoaquents

ARENTS

Central concept

Deeply mixed soils by plowing, spading or moving. Fragments of diagnostic horizon are scattered through the soil.

Definition

(+) 1. Fragments of diagnostic horizon at > 25 cm.

(+) 2. Not permanently or seasonally saturated with water (Aquents)

Great groups :

(-) Arents with an ustic regime

Ustarents

(-) Other Arents with a xeric regime

Xerarents

(-) Other Arents with a torric regime

Torriarents

(-) Other Arents

Udarents

PSAMMENTS

Central concept

Entisol is sand. Any climate or vegetation. Any age. When dry or bare : are subject to blowing or drifting, support wheeled vehicles poorly (gravelly sands are excluded from Psamments and grouped with Orthents).

Definition

(+) Sandy particle-size at > 25 cm.

(+) < 35 % (volume) gravel or coarser fragments.

(+) No fragments of diagnostic horizon (Arents).

(+) Not saturated with water (Aquents).

Great group :

(-) Psamments with a cryic or pergellic regime.

Cryopsamments

(-) Other Psamments with a torric regime.

Torripsamments

(-) Other Psamments with a sand fraction > 90 % of quartz, zircon, tourmaline rutile, and other (resistant minerals).

Quartzypsamments

(-) Other Psamments with ustic regime, warmer than cryopsamments.

Ustipsamments

(-) Other Psamments with a xeric regime.

Xeropsamments

(-) Other Psamments.

Udipsamments

FLUVENTS

Central concept

Soils formed in recent water deposite sediments, in flood plains, fans, deltas, et

But not in back swamps.

Age : very or rather young.

Flooded frequently. Stratification is normal. Contain appreciable amounts organic carbon, with irregular decrease with depth.

Definition

(+) 1. Texture : loamy fine sand or finer at > 25 cm.

(+) 2. No fragments of diagnostic horizon (Arents).

(+) 3. Slopes < 25 %.

(+) 4. Organic carbon % decreases irregularly with depth.

(+) 5. Not saturated with water (Aquents).

(+) 6. MAST 0° C or colder.

Great group:

(-) Fluvents with

- Mean Summer Soil Temperature is ≤8° C, if there is no O horizon
- Mean Summer Soil Temperature is ≤5° C, if there is an O horizon

Gelifluvents

(-) Other Fluvents with a cryic regime

Cryofluvents

(-) Other Fluvents with a xeric regime

Xerofluvents

(-) Other Fluvents with an ustic regime (warmer than cryic)

Ustifluvents

(-) Other Fluvents with a torric regime

Torrifluvents

(-) Other Fluvents (udic regime, frigid to hyperthermic but no iso-temperature regime)

Udifluvents

ORTHENTS

Central concept

Entisols on erosional surfaces. Indurated diagnostic horizon may be at the surface, but support scattered plants.

Definiton

(+) 1. Loamy very fine or finer particle-size at > 25 cm, or > 35 % (volume) coarse fragments at < 1 m.

(+) 2. No fragments of diagnostic horizon (Arents).

(+) 3. Organic carbon (%) decreasing regularly with depth.

(+) 4. Not saturated with water (Aquents).

Great groups

(-) Orthents in normal years, MAST 0°C or colder and Mean Summer Soil Temperature (MSST) is :

- 8° C or colder if there is no O horizon
- 5° C or colder if there is an O horizon

Gelorthents

(-) Other Orthents with a cryic or pergelic regime

Cryorthents

(-) Other Orthents with a torric regime

Torriorthents

(-) Other Orthents with a xeric regime

Xerorthents

(-) Other Orthents with an ustic regime (warmer than cryic).

Ustorthents

(-) Other Orthents (udic regime, frigid to hyperthermic but no iso-temperatur regime).

Udorthents

VERTISOLS

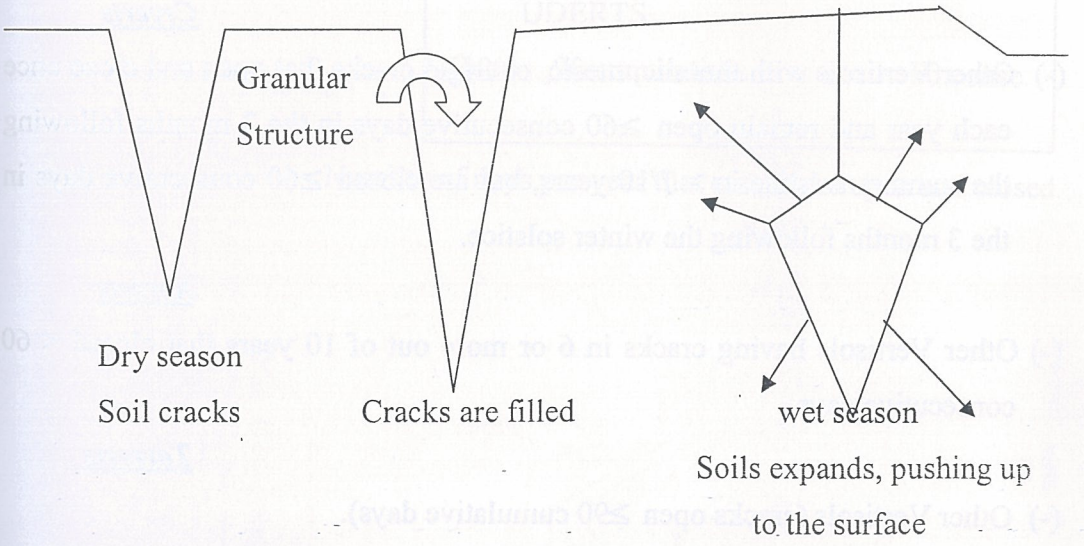
Central concept :

Clayey soils that have deep wide cracks at some time of the year, with high bulk densities between the cracks.

Genesis :

During the dry season the clayey soils cracks to adeep of 1 m or more, due to the shringkage of the 2 : 1 clays. While the cracks are open, loose surface soil material (granular structure) falls into them by several mechanism : wind, water, animals.

During the rainy season the clays hydrate and expand. The cracks close, but as the lower part is filled with material, pressure are exerted giving soil movement in oblique directions. The mechanism is at the origin of slickensides, gilgai, wedge-shape peds, self-mulching



Extention : 300.000.000 ha.

Vegetation : tall grass or savanna

Mineralogy : montmorilonitic, illitic, sometimes mixed

Climate : mesic or warmer, with changes in moisture regime (dry-moist).

Definition :

Vertisols are mineral soils that have :

(+) 1. (Iso) mesic or warmer regime.

(+) 2. No (para) lithic contact or pan at < 50 cm.

(+) 3. > 30 % clay to > 50 cm.

(+) 4. Cracks that open and close periodically

(-) 4.1. Gilgai

(-) 4.2. Slickensides

(-) 4.3. Wedge-shaped peds or see Key to Soil Orders.

KEY TO SUBORDERS OF VERTISOLS

(-) Vertisols having an aquic moisture regime

Aquerts

(-) Other Vertisols having a cryic soil temperature regime.

Cryerts

(-) Other Vertisols with thermic, mesic, or frigid cracks that open and close onc each year and remain open ≥60 consecutive days in the 3 months followin the summer solstice in > 7/10 years, but are closed ≥60 consecutive days i the 3 months following the winter solstice.

Xererts

(-) Other Vertisols having cracks in 6 or more out of 10 years that closed < 6 consecutive days.

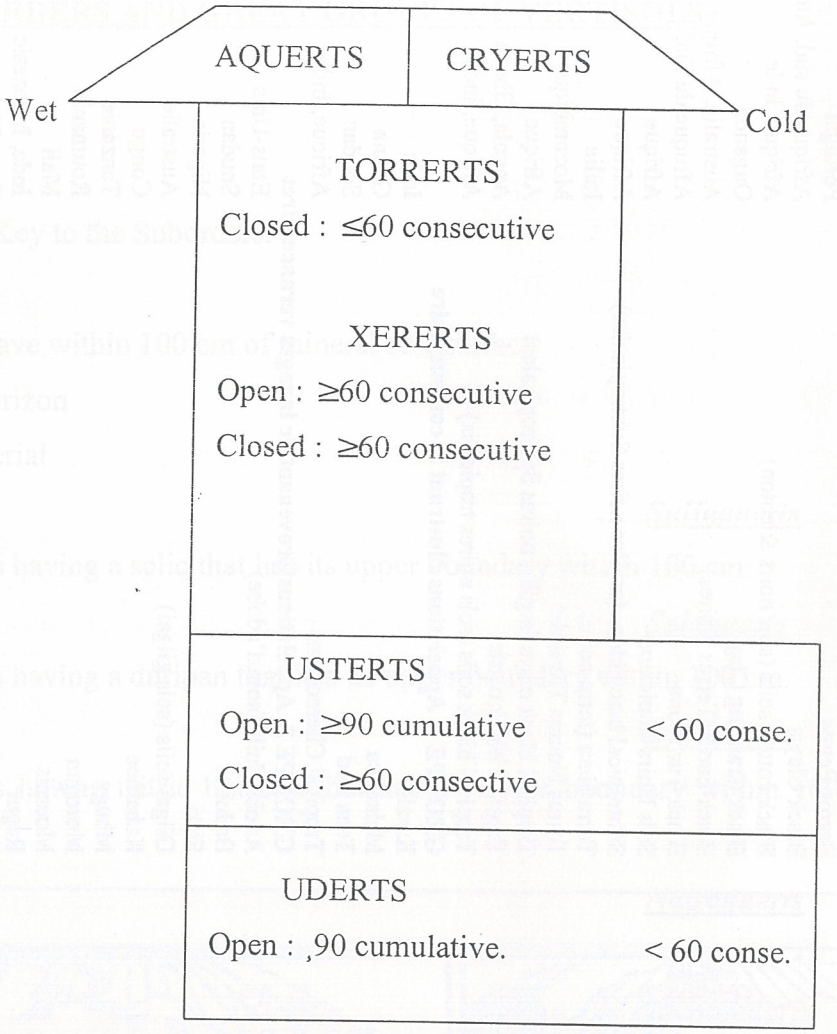
Torrerts

(-) Other Vertisols (cracks open ≥90 cumulative days).

Usterts

(-) Other Vertisols

Uderts



Number of days per year that cracks are open and closed

DARK CLAY SOIL OF TROPICAL AND SUBTROPICAL REGIONS

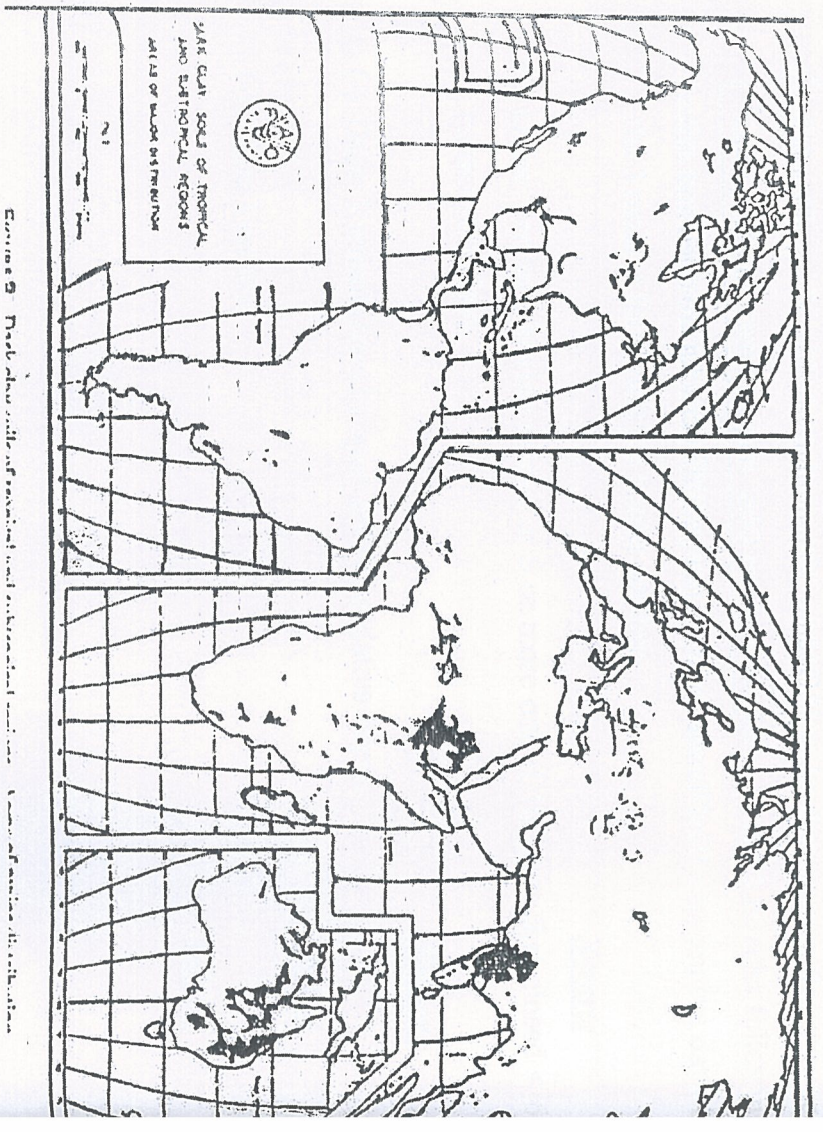


Figure 2 Distribution of tropical and subtropical [illegible]

SOLS ARGILLEUX FONCES DES REGIONS TROPICALES & SUBTROPICALES

TABLEU 1. APPELATIONS DES SOLS ARGILLEUX FONCES ET REGIONS OU ELLES SONT UTILISEES

GROUPE 1. Appelations comprenant le mor 'noir'	
Barros Petros	Portugal
Black Clays	Afrique du sud, Australie
Black cotton soils (sols noirs & coton)	Afrique, Inde
Black Cracking Clays	Ouganda
Black Earth (Terres Noires)	Australie, Afrique
Black Turf Soils	Afruque du Sud
Sols Noirs tropicaux	Afrique
Subtropical black clays (argiles noires Subtropicales)	Afrique
Terra Nera (terre noire)	Italie
Terras Nouras Tropicais	Mozambique
Tropical black clays (argiles noires Subtropicales)	Afrique
Tropical black earths	Angola, Ghana
Tropical black soils (sols noires tropicaux)	Afrique, Inde
GROUPE 2. Appelations illustrant la conteur noire	
Karail	Inde
Melanitca	Ghana
Teen Sud	Soudan
Tropical Chernozems	Afrique, Inde
GROUPE 3. Appelations provenant de launges vernaculaires	
Adobe Soils (sols d'adobe)	Etats-Unis
Badobes	Soudan
Firki	Nigeria
Gilgai soils (sols gilgai)	Australie
Kahamba	Congo
Mbuga	Tanzanie
Morogan	Roumanie
Mourcis	Mali
Regur	Inde, Indonesie
Rendzina	Etats-Unis
Smolnitza	Bulgarie, Roumanie
Smonitza	Autriche, Yougoslavie
Sols de Paluds	France
Sonsocuite	Nicaragua
Tirs	Afrique du Nord
Vlei Soils	Afrique du Sud
	Yougoslavie

SUBORDERS AND GREAT GROUPS OF VERTISOLS

AQUERTS

Definition : See Key to the Suborders.

Great groups :

(-) Aquerts that have within 100 cm of mineral soil surface

- A sulfuric horizon
- Sulfidic material

Sulfaquerts

(-) Other Aquerts having a salic that has its upper boundary within 100 cm.

Salaquerts

(-) Other Aquerts having a duripan that has its upper boundary within 100 cm.

Duraquerts

(-) Other Aquerts having natric horizon that has its upper boundary within 100 cm.

Natraquerts

(-) Other Aquerts having a calcic horizon.

Calciaquerts

(-) Other Aquerts having one or more horizons with a total thickness ≥25 cm at ≤ 50 cm,

(+) An electrical conductivity of the saturation extract ≤4,0 dS/m at 25° C

(+) A pH value ≤4.5 in 0.001 M $CaCl_2$ (≤5 in 1 : 1 water)

Dystraquerts

(-) Other Aquerts having episaturation.

Epiaquerts

(-) Other Aquerts

Endoaquerts

CRYERTS

Definition : See Key to the Suborders

Great groups :

(-) Cryerts having ≥10 Kg/m^2 organic carbon between the mineral soil surfac and a depth of 50 cm.

Humicryerts

(-) Other Cryerts

Haplocryerts

XERERTS

Central concept

Vertisols of mediterreanean climates, with cool wet winters and warm dr summers.

Thermic or mesic temperature regime (not iso-).

Definition : See Key to the Suborders

Great groups :

(-) Xererts having a duripan that has its upper boundary within 100 cm.

Durixererts

(-) Other Xererts having a calcic or petrocalcic horizon that has its upper boundar within 100 cm.

Calcixererts

(-) Other Xererts

Haploxererts

TORRERTS

Central concepts

Vertisols of arid climates.

Definition : See Key to the Suborders

Great groups :

(-) Torrerts having a salic horizon that has its upper boundary within 100 cm.

Salitorrerts

(-) Other Torrerts having a gypsic horizon that has its upper boundary within 100 cm.

Gypsitorrerts

(-) Other Torrerts having a calcic or petrocalcic horizon that has its upper boundary within 100 cm.

Calcitorrerts

(-) Other Torrerts

Haplotorrerts

USTERTS

Central concept

Vertisols of monsoon climates, tropical or subtropical areas having 2 rainy and 2 dry seasons, temperate regions having limited summer rains.

Definition : See key to the Suborders

Great groups :

(-) Usterts having one or more horizons with a total thickness ≥25 cm at ≤50 cm,

(+) 1. An electrical conductivity of the saturation extract ≤4.0 dS/m at 25°C.

(+) 2. A pH value ≤4.5 in 0.001 M $CaCl_2$ (≤5 in 1 : 1 water)

Dystrusterts

(-) Other Usterts having a salic horizon that has its upper boundary within 100 cm.

Salusterts

(-) Other Usterts having a gypsic horizon that has its upper boundary within 100 cm.

Gypsiusterts

(-) Other Usterts having a calcic or petrocalcic horizon that has its upper boundary within 100 cm.

Calciusterts

(-) Other Usterts

Haplousterts

UDERTS

Central concept :

Vertisols of humid climates.

Definition : See key to the Suborders

Great groups :

(-) Uderts having one or more horizons with a total thickness ≥25 cm at ≤50 cm,

(+) 1. An electrical conductivity of the saturation extract ≤4.0 dS/m at 25°C.

(+) 2. A pH value ≤4.5 in 0.001 M $CaCl_2$ (≤5 in 1 : 1 water)

Dystruderts

(-) Other Uderts

Haplouderts

INCEPTISOLS

Central concept :

Soils of humid regions with weakly to moderately weathered B horizon, mostly cambic horizon. Also soils on volcanic ash, and with plaggen epipedon.

Genesis : The reasons for weak development of the soil are :

- Highly resistant parent material,
- Abundance of volcanic ash,
- Relief : steep slopes, depressions,
- Geomorphic young surfaces.

Most inceptisols evaluate toward other soils; some however are in equilibrium with their environment and will not "mature".

Diagnostic horizon :

Epipedon : any, but mostly ochric, umbric.

Subsurfce : cambic horizon, fragipan, duripan, (petro) calcic, placic, C horizon.

Most common horizon sesquences : Ochric/cambic/(fragipan)

Umbric/cambic/(fragipan, duripan)

Plaggen/buried soil

Exluded : shallow plinthite, natric, argillic, spodic, oxic, (petro) gypsic, salic horizon.

Moisture and temperature regime :

Subhumid to humid, equatorial to tundra.

Parent material : old and young surfaces and deposits.

Definition :

Inceptisols are mineral soils that have : See Key to the Orders

KEY TO SUBORDERS OF INCEPTISOLS

(-) Inceptisols having :

(-) 1. Aquic condition in a layer above a densic, lithic, or paralithic contact or in depth between 40 and 50 cm for sometime in normal year (or artificial drainage) and;

(-) 1.1. Histic epipedon

(-) 1.2. Suluric horizon at < 50 cm.

(-) 1.3. A layer directly under epipedon or within 50 cm that has on faces of peds ≥50 % chroma

(-) 1.3.1. ≤2 if they are redox concentrations

(-) 1.3.2. ≤1.

(-) 1.4. Ochric epipedon within 50 cm of the mineral soil surface, enough active ferrous iron.

(-) 2. An ESP > 15 % or SAR ≥13 % in half or more of the soil volume within 50 cm depth, a decrease ESP and SAR with increasing depth and groundwater within 100 cm for sometime during the year tha decreases with depth below 50 cm, and there is groundwater at < m.

Aquepts

(-) Other Inceptisols having a plaggen or anthropic epipedon.

Anthrepts

(-) Other Inceptisols that have, in normal year Mean Annual Soil Temperature ≤0° C and Mean Summer Soil Temperature :

(-) 1. ≤8 C if there is no O horizon

(-) 2. ≤5 C if there is an O horizon

Gelepts

(-) Other Inceptisols having a cryic temperature regime.

Cryepts

(-) Other Inceptisols having an ustic moisture regime.

Ustepts

(-) Other Inceptisols having xeric moisture regime.

Xerepts

(-) Other Inceptisols that have a udic moisture regime.

Udepts

SUBORDERS AND GREAT GROUPS OF INCEPTISOLS

AQUEPTS

Central concept :

Wet Inceptisols . Groundwater close to the surface some time of the year but not all seasons. Mottled horizon begines at < 50 cm.

Very flat plains, any climate, any vegetation, any texture (except fragmental). Most have cambic horizon (some a fragipan or plaggen epipedon).

Definion : See Key to the suborders

Great groups :

(-) Aquepts having sulfuric horizon at < 50 cm.

Sulfaquepts

(-) Other Aquepts having plinthite or cemented or indurated diagnostic horizon at < 1 m.

Petraquepts

(-) Other Aquepts having ESP ≥15 % or SAR ≥13 % in the upper 50 cm and that decreases below 50 cm.

Halaquepts

(-) Other Aquepts having a fragipan that has its upper boundary within 100 cm.

Fragiquepts

(-) Other Aquepts that have, in normal year Mean Annual Soil Temperature of ≤ 0°C and Mean Summer Soil Temperature :

(-) 1. ≤8 C if there is no O horizon

(-) 2. ≤5 C if there is an O horizon

Gelaquepts

(-) Other Aquepts having a cryic or pergelic regime.

Cryaquepts

(-) Other Aquepts having ≥25 % by volume recognizable bioturbation, animal borrows, whormhole, or cast.

Vermaquepts

(-) Other Aquepts that have a histic, melanic, mollic, or umbric epipedon.

Humaquepts

(-) Other Aquepts having episaturation.

Epiaquepts

(-) Other Aquepts.

Endoaquepts

ANTHREPTS

(-) Anthrepts that have a plaggen epipedon.

Plagganthrepts

(-) Other Anthrepts

Haplanthrepts

GELEPTS

(-) Gelepts that have

(-) 1. Free carbonate within the soil.

(-) 2. V ≥60 % (by NH_4OHAc) in 25-75 cm or directly above root limiting layer.

Eutrogelepts

(-) Other Gelepts.

Dystrogelepts

CRYEPTS

(-) Cryepts that have

(-) 1. Free carbonate within the soil

(-) 2. V $\geq$ 60 % (by NH_4OHAc) in 25-75 cm or directly above root limiting layer.

Eutrocryepts

(-) Other Cryepts.

Dystrocryepts

USTEPTS

(-) Ustepts that have a duripan that has its upper boundary within 100 cm.

Durustepts

(-) Other Ustepts that have :

(-) 1. Calcic horizon with its upper boundary within 100 cm.

(-) 2. Calcareous or have texture of loamy fine sand or coarser, above calcic horizon or petrocalcic horizon.

Calciustepts

(-) Other Ustepts that

(-) 1. No free carbonate within 200 cm.

(-) 2. V < 60 % (by NH_4OHAc) within 25-75 cm.

Dystrustepts

(-) Other Ustepts.

Haplustepts

XEREPTS

(-) Xerepts that have duripan that has its upper boundary within 100 cm.

Durixerepts

(-) Other Xerepts that

(-) 1. Have a calcic horizon with its upper boundary within 100 cm or petrocalcic horizon with its upper boundary 150 cm.

(-) 2. Are calcareous in all part above the calcic or petrocalcic horizon.

Calcixerepts

(-) Other Xerepts that have fragipan that has its upper boundary within 100 cm.

Fragixerepts

(-) Other Xerepts that :

(-) 1. No free carbonate within 200 cm.

(-) 2. V < 60 % (by NH_4OHAc) within 25-75 cm

Dystroxerepts

(-) Other Xerepts

Haploxerepts

UDEPTS

(-) Udepts that have a sulfuric horizon within 50 cm.

Sulfudepts

(-) Other Udepts that have a duripan that has its upper boundary within 100 cm.

Durudepts

(-) Other Udepts that have fragipan that has its upper boundary within 100 cm.

Fragiudepts

(-) Other Udepts that have

(-) 1. Free carbonate within the soil

(-) 2. V $\geq$ 60 % (by NH_4OHAc) in 25-75 cm or directly above root limiting layer.

Eutrodepts

(-) Other Udepts.

Dystrudepts

ANDISOLS

Central concept :

Andisols includes weakly weathered soils which much volcanic glass as well as more strongly weathered soils rich in short-range-order minerals. Hence the content of volcanic is one of the characteristic used in defining andic soil properties.

KEY TO THE SUBORDERS OF ANDISOLS

(-) Andisols that have

(-) 1. A histic epipedon

(-) 2. In a layer above densic,or (para) lithic contact or at a depth 40-50 cm from mineral soil surface or from the top of organic layer with andic soil properties, aquic condition in some time in normal years (or artificial drainage) and

(-) 2.1. ≥2 % redox concentration

(-) 2.2. A color value, moist ≥4 and ≥50 % chroma of ≤2 in redox depletion on faces of peds or in the matrix if peds are absent

(-) 2.3. Enough active ferrous iron positive reaction to $\alpha\alpha$ dipyridyl if soil is not irrigated.

Aquands

(-) Other Andisols in normal years Mean Annual Soil Temperature of ≤0°C and Mean Summer Soil Temperature :

(-) 1. ≤8°C if there is no O horizon

(-) 2. ≤5°C if there is an O horizon

Gelands

(-) Other Andisols that have a cryic temperature regime

Cryands

(-) Other Andisols that have aridic moisture ragime

Torrands

(-) Other Andisols that have xeric moisture regime

Xerands

(-) Other Andisols that have pF 4.2 < 15 % on air dried samples and < 30 % in undried samples throughout ≥60 % of the thickness :

(-) 1. Within 60cm of the mineral soil surface or at the top of an organic layer with andic soil properties if there is no densic, or (para) lithic contact

(-) 2. Between either mineral soil surface or at the top of organic layer with andic soil properties, whichever is shallower and densic, or (para) lithic contact.

Vitrands

SUBORDERS AND GREAT GROUPS OF ANDISOLS

AQUANDS

Definition : see key of suborders

Great groups :

(-) See Gelands, Aquands that have Gelands

Gelaquands

(-) Other Aquands that have a cryic soil temperature regime

Cryaquands

(-) Other Aquands that have in ≥half of each pedon a placic horizon within 100 cm of the mineral soil surface or at the top of an organic layer with andic soil properties whichever is shallower

Placaquands

(-) Other Aquands that have in ≥75 % of each pedon a duripan, a cemented horizon that has its upper boundary within 100 cm of the mineral soil surface or at the top of an organic layer with andic soil properties whichever is shallower

Duraquands

(-) Other Aquands that have pF 4.2 < 15 % on air dried samples and < 30 % in undried samples throughout ≥60 % of the thickness :

(-) 1. Within 60cm of the mineral soil surface or at the top of an organic layer with andic soil properties, whichever is shallower if there is no densic, or (para) lithic contact.

(-) 2. Between either mineral soil surface or at the top of organic layer with andic soil properties, whichever is shallower and densic, or (para) lithic contact.

Vitraquands

(-) Other Aquands that have a melanic epipedon

Melanaquands

(-) Other Aquands that have episaturation

Epiaquands

(-) Other Aquands

Endoaquands

GELANDS

(-) All Gelands are considered vitrigelands

Vitrigelands

CRYANDS

Definition : see key of suborders

Great groups :

(-) Cryands that have, in ≥75 % of each pedon a cemented horizon that has upper boundary within 100 cm of the mineral soil surface or at the top of organic layer with andic soil properties whichever is shallower

Duricryands

(-) Other Cryands that have, on undried samples; 1500 kPa water retention of ≥ 100 %, by weighted average, throughout

(-) 1. ≥layer with a total thickness 35 cm between mineral soil surface to 100 cm or from the top of an organic layer with andic soil properties, whichever is shallower, if there is no densic, or (para) lithic contact.

(-) 2. ≥60 % of the horizon thickness between either the mineral soil surface or the top of an organic layer with andic soil properties, whichever is shallower, and a densic, or (para) lithic contact.

Hydrocryands

(-) Other Cryands that have a melanic epipedon

Melanocryands

(-) Other Cryands that have a layer that meet depth, thickness, and organic carbon requirements for melanic epipedon

Fluvicryands

(-) Other Cryands that have pF 4.2 < 15 % on air dried samples and < 30 % in undried samples throughout ≥60 % of the thickness :

(-) 1. Within 60 cm of the mineral soil surface or at the top of an organic layer with andic soil properties, whichever is shallower if there is no densic, or (para) lithic contact.

(-) 2. Between either mineral soil surface or at the top of organic layer with andic soil properties, whichever is shallower and densic, or (para) lithic contact.

Vitricryands

(-) Other Cryands

Haplocryands

TORRANDS

Definition : see key of suborders

Great groups :

(-) Torrands that have, in ≥75 % of each pedon a cemented horizon that has upper boundary within 100 cm either of the mineral soil surface or at the top of organic layer with andic soil properties whichever is shallower

Duritorrands

(-) Other Torrands that have pF 4.2 < 15 % on air dried samples and < 30 % in undried samples throughout ≥60 % of the thickness :

(-) 1. Within 60cm either of the mineral soil surface or at the top of an organic layer with andic soil properties, whichever is shallower if there is no densic, or (para) lithic contact within that depth.

(-) 2. Between either mineral soil surface or at the top of organic layer with andic soil properties, whichever is shallower, and densic, or (para) lithic contact.

Vitritorrands

(-) Other Torrands

Haplotorrands

XERANDS

Definition : see key of suborders

Great groups :

(-) Xerands that have pF 4.2 < 15 % on air dried samples and < 30 % in undried samples throughout ≥60 % of the thickness :

(-) 1. Within 60cm either of the mineral soil surface or at the top of an organic layer with andic soil properties, whichever is shallower if there is no densic, or (para) lithic contact

(-) 2. Between either mineral soil surface or at the top of organic layer with andic soil properties, whichever is shallower, and densic, or (para) lithic contact.

Vitrixerands

(-) Other Xerands that have a melanic epipedon

Melanoxerands

(-) Other Xerands

Haploxerands

VITRANDS

Definition : see key of suborders

Great groups :

(-) Vitrands that have an ustic soil moisture regime

Ustivitrands

(-) Other Vitrands

Udivitrands

USTANDS

Definition : see key of suborders

Great groups :

(-) Ustands that have, in ≥75 % of each pedon a cemented horizon that has upper boundary within 100 cm either of the mineral soil surface or at the top of organic layer with andic soil properties whichever is shallower.

Durustands

(-) Other Ustands

Haplustands

UDANDS

Definition : see key of suborders

Great groups :

(-) Other Udands that have in ≥half of each pedon a placic horizon within 100 cm either of the mineral soil surface or at the top of an organic layer with andic soil properties whichever is shallower

Placudands

(-) Other Udands that have in ≥75 % of each pedon a duripan, a cemented horizon that has its upper boundary within 100 cm either of the mineral soil surface or at the top of an organic layer with andic soil properties whichever is shallower

Durudands

(-) Other Udands that have a melanic epipedon

Melanudands

(-) Other Udands that have a layer that meets the depth, thickness, and organic carbon requirements for melanic epipedon

Fluvudands

(-) Other Udands that have at pF 4.2 ≥100 % undried samples, by weighted average, throughout

(-) 1. ≥layer with a total thickness 35 cm between mineral soil surface to 100 cm or from the top of an organic layer with andic soil properties, whichever is shallower, and 100 cm depth or from the top of an organic layer with andic soil properties, whichever is shallower if there is no densic, or (para) lithic contact

(-) 2. ≥60 % of the horizon thickness between either the mineral soil surface or the top of an organic layer with andic soil properties, whichever is shallower, and a densic, or (para) lithic contact

Hydrudands

(-) Other Udands

Hapludands

ARIDISOLS

Central concept :

Soils that have no water available to mesophytic plants for long periods, the water being held at tensions > 15 bar or being salty, or both.

Genesis :

Because of the limited amount of water, there is a lack of leaching, leaving the soils with a high base status and often with a cambic horizon. The presence of an argillic horizon maybe due to weathering in situ or lessivage (often under a former more humide climate). Many aridisols have calcic or petrocalcic horizon (caliche) or other salt accumulation (sodium, gypsum). If gravel is present, the surface has a desert pavement.

Extension : ± 30 % of the world.
Desertic, or semi-desertic regions.

Diagnostic horizon:
Epipedons : Ochric, anthropic
Subsurface : Cambic
Argillic, natric
(petro) calcic, (petro) gypsic, salic, duripan
Excluded : spodic, oxic

Climate : temperature regime : frigid to isohyperthermic
moisture regime : aridic (ustic, xeric)

Vegetation : ephemeral grasses, forbs, scattered xerophytic plants.

KEY TO THE SUBORDERS OF ARIDISOLS

(-) Aridisols having a cryic soil temperature regime.

Cryids

(-) Other Aridisols having a salic horizon, that has its upper boundary within 100 cm of the soil surface.

Salids

(-) Other Aridisols having a duripan, that has its upper boundary within 100 cm of the soil surface.

Durids

(-) Other Aridisols having a gypsic or petrogypsic horizon, that has its upper boundary within 100 cm and do not have a petrocalcic horizon overlying these horizon.

Gypsids

(-) Other Aridisols having an argillic or natric horizon and do not have a petrocalcic that has its upper boundary within 100 cm of the soil surface.

Argids

(-) Other Aridisols having a calcic or petrocalcic horizon, that has its upper boundary within 100 cm.

Calcids

(-) Other Aridisols

Cambids

SUBORDERS AND GREAT GROUPS OF ARIDISOLS

CRYIDS

Definition : see key of suborders

Great groups :

(-) Cryids having a salic horizon, that has its upper boundary within 100 cm of the soil surface.

Salicryids

(-) Other Cryids having a duripan, petrocalcic or petrogypsic horizon, that has its upper boundary within 100 cm of the soil surface.

Petrocryids

(-) Other Cryids having a gypsic horizon, that has its upper boundary within 100 cm of the soil surface.

Gypsicryids

(-) Other Cryids having an argillic or natric horizon.

Argicryids

(-) Other Cryids having a calcic horizon, that has its upper boundary within 100 cm of the soil surface.

Calcicryids

(-) Other Cryids

Haplocryids

SALIDS

Definition : see key of suborders

Great groups :

(-) Salids that are saturated with water in one or more layers within 100 cm for 1 month or more in normal years.

Aquisalids

(-) Other Salids

Haplosalids

DURIDS

Definition : see key of suborders

Great groups :

(-) Durids having a natric horizon above the duripan

Natridurids

(-) Other Durids having an argillic horizon above the duripan

Argidurids

(-) Other Durids

Haplodurids

GYPSIDS

Definition : see key of suborders

Great groups :

(-) Gypsids having a petrogypsic or petrocalcic horizon, that has its upper boundary within 100 cm of the soil surface.

Petrogypsids

(-) Other Gypsids having a natric horizon, that has its upper boundary within 100 cm of the soil surface.

Natrigypsids

(-) Other Gypsids having an argillic, that has its upper boundary within 100 cm of the soil surface.

Argigypsids

(-) Other Gypsids having a calcic horizon, that has its upper boundary within 100 cm of the soil surface.

Calcigypsids

(-) Other Gypsids

Haplogypsids

ARGIDS

Central concept

Aridisols with an argillic or nitric horizon, eventually with (petro) calcic horizon or duripan.

Argids with argillic horizon are mostly old soils.

Definition :

Argids are aridisols with an argillic or natric horizon.

Great groups :

(-) Argids having duripan or petrocalcic or petrogypsic, that has its upper boundary within 150 cm of the soil surface.

Petroargids

(-) Other Argids having a natric horizon.

Natrargids

(-) Other Argids do not have a (para) lithic contact within 50 cm of the soil surface,

(-) 1. An increase of ≥15 % clay (absolute), within a vertical distance of 2.5 cm either within the argillic or at its upper boundary,

(-) 2. An argillic horizon that extends to ≥150 cm from the soil surface, that no clay decrease with increasing depth ≥20 % (relative) from the max clay content, and has in ≥50 % of the matrix, in some part between 100-150 cm,

(-) 2.1. Hues of 7.5 YR or redder and chroma ≥5

(-) 2.2. Hues of 7.5 YR or redder and value, moist ≤3 and value dry ≤4.

Paleargids

(-) Other Argids having a gypsic horizon, that has its upper boundary within 150 cm of the soil surface.

Gypsiargids

(-) Other Argids having a calcic horizon, that has its upper boundary within 150 cm of the soil surface.

Calciargids

(-) Other Argids (having an argillic horizon).

Haploargids

CALCIDS

Definition : see key of suborders

Great groups :

(-) Calcids having a petrocalcic horizon, that has its upper boundary within 100 cm of the soil surface.

Petrocalcids

(-) Other Calcids

Haplocalcids

CAMBIDS

Definition : see key of suborders

Great groups :

(-) Cambids having an aquic moisture regime for some time in normal years in ≥ 1 layers within 100 cm of the soil surface.

Aquicambids

(-) Other Cambids having a duripan or petrocalcic or petrogypsic horizon, that has its upper boundary within 150 cm of the soil surface.

Petrocambids

(-) Other Cambids having an anthropic epipedon

Anthracambids

(-) Other Cambids

Haplocambids

MOLLISOLS

Central concept :

Steppe and praire soils with thick, dark surface horizon, with high organic matter content and high base saturation (mollic epipedon).

Genesis :

The most important feature is darkening of the soil (melanization) by organic matter, involving the following processes :

- Extension of root of praire vegetation in the soil,
- Partial decay of organic materials and production of relatively stable dark compounds (200-1000 kg (dry) organic matter/year/ha),
- Reworking of the soil by soil fauna (40-80 tons of subsoil/year/ha can be brought to the surface; the upper 50 cm are turned over completely once of century by ants, worm, rodents),
- Eluviation and illuviation of humus and eventually clay, producing dark cutans on the peds,
- Production of resistant ligno-protein residues giving a black color even to long cultivated mollisols.

Extension : ± 13.000.000 Km^2.

Diagnostic horizons :

(+)1. Mollic epipedon

(-) 2. Cambic, argillic, natric, albic horizon
(petro) calcic, gypsic, horizon, duripan, C horizon.

Climate : Subhumid to semi-arid; any moist or temperature regime.

Vegetation : praire and steppes,
Tall-grass (1-3 m), middle-grass (30-100 cm), short-grass (10-30 cm)

(-) 5.1.2.1. ≥50 % chroma of 1 on face of peds or in the matrix, hue of 10 YR or redder and redox concentration

(-) 5.1.2.2. ≥50 % chroma of ≤2 on face of peds or in the matrix, hue of 2,5 YR, and redox concentration.

(-) 5.1.2.3. ≥50 % chroma of 1 on faces of peds or in the matrix, hue of 2,5 YR or yellower

(-) 5.1.2.4. ≥50 % chroma of ≤on faces of peds or in the matrix , hue of 5 Y and redox concentration

(-) 5.1.2.5. ≥50 % chroma of 0 on faces of peds or in the matrix

(-) 5.1.2.6. Hue of 5 GY, 5 G, 5 BG, or 5B

(-) 5.1.2.7. Any color if it result from uncoated sand grains

(-) 5.2. Chroma of 2 in the lower part of the mollic epipedon and,

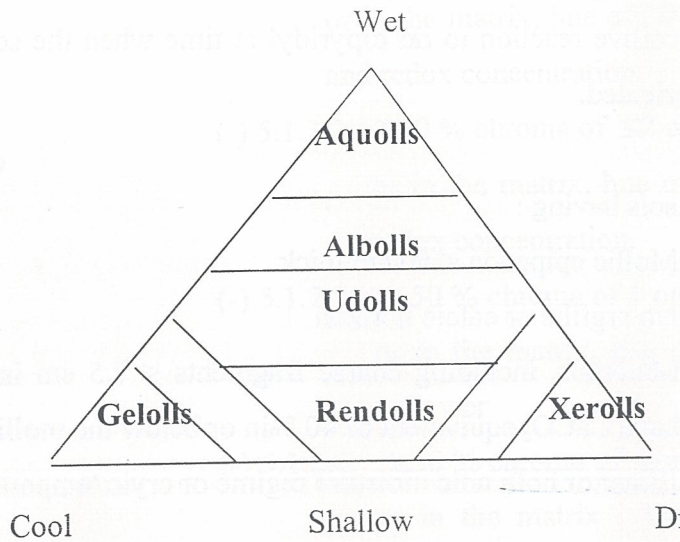
(-) 5.2.1. Distinct or prominent redox concentration in the lower part of mollic epipedon.

(-) 5.2.2. Directly below the mollic epipedon, and matrix colors

(-) 5.2.2.1. A color value, moist 4, chroma of 2 and some redox depletions with color value, moist of ≥4 and chroma of ≤ 1

(-) 5.2.2.2. A color value, moist of 4 and chroma of ≤2, and redox contrentration.

(-) 5.2.2.3. A color value, moist, of 4 and choma ≤1



SUBORDERS AND GREAT GROUPS OF MOLLISOLS

ALBOLLS

Central concept :

Mollisols with an albic horizon and fluctuating groundwater

Vegetation : Probably forest succeeded by grass

Definition : See key of suborders

Classification 1938 : Planosols

Great Groups :

(-) Albolls having a natric

Natralbolls

(-) Other Albolls having an argillic horizon

Argialbolls

AQUOLLS

Central concept :

Wet Mollisols with dominant low chromas, olive hues, high contrast mottles below the black epipedon.

Classification 1938 : Humic Gley soils

Great groups :

(-) Aquolls having a cryic soil temperature regime.

Cryaquolls

(-) Other Aquolls having a duripan that has upper boundary within 100 cm.

Duraquolls

(-) Other Aquolls having a natric horizon

Natraquolls

(-) Other Aquolls having a calcic or gypsic horizon that has upper boundary within 40 cm of thye mineral soil surface but do not have an unless it is a buried horizon.

Calciaquolls

(-) Other Aquolls having an argillic horizon.

Argiaquolls

(-) Other Aquolls having episaturation.

Epiaquolls

(-) Other Aquolls

Endoaquolls

RENDOLLS

Central concept :

Mollisols of humid regions, mainly under forest, from highly calcareous parent material. The mollic epipedon rests on calcareous parent material, or on a cambic horizon rich in carbonates.

Definition : See key to the suborders

Cassification 1938 : Rendzina

Great groups :

(-) Rendolls having a cryic soil temperature regime

Cryrendolls

(-) Other Rendolls

Haprendolls

GELOLLS

Key to Great goups all Gelolls

Hapgelolls

CRYOLLS

(-) Cryolls that have a duripan that has its upper boundary within 100 cm of the mineral soil surface.

Duricryolls

(-) Other cryolls that have a natric horizon

Natricryolls

(-) Other cryolls that have

(-) 1. An argillic horizon that has its upper boundary ≥60 cm below the mineral soil surface

(-) 2. A texture finer than loamy fine sand in all horizons above the argillic horizon

Palecryolls

(-) Other Cryolls that have an argillic horizon

Argicryolls

(-) Other Cryolls that have

(-) 1. A calcic or petrocalcic horizon that has its upper boundary within 100 cm.

(-) 2. In all parts above the calcic or petrocalcic horizon, after the materials to a depth 18 cm have been mixed, either are calcareous or have a texture of loamy fine sand or corser.

Calcicryolls

(-) Other Cryolls

Haplocryolls

XEROLLS

Central concept :

Mollisols with Mediterranean climate (xeric regime)

Great groups :

(-) Xerolls having a duripan at < 1 m

Durixerolls

(-) Other Xerolls having a natric horizon

Natrixerolls

(-) Other Xerolls having

(-) 1. A petrocalcic horizon that has its upper boundary within 150 cm

(-) 2. An argillic horizon that has its upper boundary,

(-) 2.1. With increasing depth no clay decrease ≥20 % within 150 cm (and there is no densic, or (para) lithic contact within that depth) and,

(-) 2.1.1. Hue of 7.5 YR or redder or chroma ≥5 in the matrix

(-) 2.1.2. Common redox concentration with hue of 7.5 YR or redder or chroma ≥6 or both.

(-) 2.2. A caly or clayey-skeletal particle size class in its upper part and, at its upper boundary, clay increase either ≥ 20 (absolute) within vertical distance of 7.5 cm or of ≥15 % within vertical distance of 2.5 cm, in the fine earth fraction (and there is no densic, or (para) lithic contact within 50 cm)

Palexerolls

(-) Other Xerolls having a calcic or gypsic horizon that has its upper boundary within 150 cm, and in all parts above the calcic or gypsic hyorizon, after have been mixed to depth of 18 cm, either are calcareous or have a texture of loamy fine sand or coarser.

Calcixerolls

(-) Other Xerolls having an argillic horizon.

Argixerolls

(-) Other Xerolls

Haplaxerolls

USTOLLS

Central concept :

Mollisols of mid to low latitudes with subhumid to semi-arid climates.

Great groups :

(-) Ustolls having a duripan that has its upper boundary within 100 cm.

Durustolls

(-) Other Ustolls having a natric horizon

Natrustolls

(-) Other Ustolls as Palexerolls except a clayey or clayey-skeletal particle size class changes to ≥35 % clay.

Paleustolls

(-) Other Ustolls that

(+) 1. Have a calcic or gypsic horizon that has its upper boundary within 100 cm or a petrocalcic horizon that has its upper boundary within 150 cm.

(+) 2. Do not have an argillic horizon above the calcic, gypsic, or petrocalcic horizon.

(+) 3. In all parts above the calcic, gypsic, or petrocalcic horizon, after the materials to depth of 18 cm have been mixed, either are calcareous or have a texture of loamy fine sand or coarser

Calciustolls

(-) Other Ustolls having an argillic horizon

Argiustolls

(-) Other Ustolls that have a mollic epipedon that

(+) 1. Either below an Ap horizon or below a depth of 18 cm from the minerals soil surface, contains ≥50 % (by volume) wormholes, wormcast, or filled animal borrow.

(+) 2. Either rest on a lithic contact or has a transition zone to underlying horizon in which ≥25 % of the soil volume consist of discrete wormholes, wormcasts, or animal borrow filled with material from the mollic epipedon and from the underlying horizon.

Vermustolls

(-) Other Ustolls

Haplustolls

UDOLLS

Central concept :

Mollisols of humid continental climates in mid-latitudes. Have a mollic epipedon + cambic, an argillic, or C horizon.

Vegetation : Tall grass; some have supported a boreal forest that was supplanted by grasses several thousand of years ago.

Temperature : Mesic or warmer

Moisture regime : Udic.

Great Groups :

(-) Udolls that have a natric horizon

Natrudolls

(-) Other udolls that have

(+) 1. A calcic or petrocalcic horizon that has its upper boundary within 100 cm.

(+) 2. Do not have an argillic horizon above the calcic or petrocalcic horizon.

(+) 3. In all parts above the calcic, gypsic, or petrocalcic horizon, after the materials to depth of 18 cm have been mixed, either are calcareous or have a texture of loamy fine sand or coarser

Calciudolls

(-) Other udolls that have

(-) 1. A petrocalcic horizon that has its upper boundary within 150 cm.

(-) 2. All of the following

(+) 2.1. No densic, or (para) lithic contact within 150 cm

(+) 2.2. Within 150 cm, a clay decrease, with increasing depth < 20 % (non carbonates clay)

(+) 2.3. An argillic horizon with

(-) 2.3.1. ≥50 % of the matrix of ≥1 subhorizon in its lower half, hue of 7.5 YR or redder and chroma of ≥5.

(-) 2.3.2. ≥50 % of the matrix of horizon that the total more than one half the total thickness, hue 2.5 YR or redder, a value moist of ≤3, and value dry ≤4.

(-) 2.3.3. More redox concentration with hue of 5 YR or redder or chroma ≥6, or both, in one or more subhorizon,

(-) 3. A frigid temperature regime and

(+) 3.1. An argillic horizon that its upper boundary ≥60 cm.

(+) 3.2. A texture finer than loamy fine sand in all horizons above the argillic horizon.

Paleudolls

(-) Other udolls that have an argillic horizon

Argiudolls

(-) Other Udolls that have a mollic epipedon that

(+) 1. Either below an Ap horizon or below a depth of 18 cm from the minerals soil surface, contains ≥ 50 % (by volume) wormholes, wormcast, or filled animal borrow.

(+) 2. Either rest on a lithic contact or has a transition zone to underlying horizon in which ≥ 25 % of the soil volume consist of discrete wormholes, wormcasts, or animal borrow filled with material from the mollic epipedon and from the underlying horizon.

Vermudolls

(-) Other Udolls

Hapludolls

SPODOSOLS

Central concept :

Soils with spodic horizon with amorphous mixtures of organic matter and Al, with or without Fe, many have an albic horizon, some have a placic horizon. The texture is mostly sandy or coarser.

Genesis :

The processes of spodosol formation are mainly the following :

- Accumulation of organic matter (mor-type)
- Acidification and leaching (podzolisation)
- Translocation of Fe, Al, and organic matter (humic and fulvic acids) from A to B horizon,
- Eventually cementation (orstein, alios).

Location : extensive surfaces in northen Eurasia and northen America.

Diagnostic horizons :

Epipedon : ochric (histic, umbric, anthropic)

Subsurface : spodic, placic, albic horizon, fragipan, duripan

Excluded : mollic epipedon, oxic, calcic, gypsic, salic horizon,

Most common horizon sesquences :

O – A1 – A2 – Bh/ir

O – A1 – Bh/ir

O – A2 – Bh/ir

And the same sesquences with Ap as surface horizon.

Climate : cool, humid or perhumid.

Moisture regime : aquic or udic

Temperature regime : any

Vegetation : forest (mostly coniferous), heath.

Remarks :

1. An albic horizon A2 may be present or absent
2. If the albic horizon is > 2 m thick, the soil is classified as entisol (psamment)
3. The spodic horizon may be biologically partly destroyed under cultivation (lime, nitrogen) or by some tree-roots
4. The subsoil may contain an argillic horizon (bisequum).

KEY TO THE SUBORDERS OF SPODOSOLS

(-) Spodosols that have an aquic moisture regime (unless artificially drained) and have in one or more horizons within 50 cm :

(-) 1. A histic epipedon

(-) 2. Within 50 cm, redoximorphic features in an albic or spodic horizons

Aquods

(-) Other Spodosols that have, in normal years Mean Annual Soil Temperature of 0°C or colder and Mean Summer Soil Temperature that :

(-) 1. ≤8° C if there is no O horizon

(-) 2. ≤5° C if there is an O horizon

Gelods

(-) Other Spodosols that have a cryic or pergelic temperature regime.

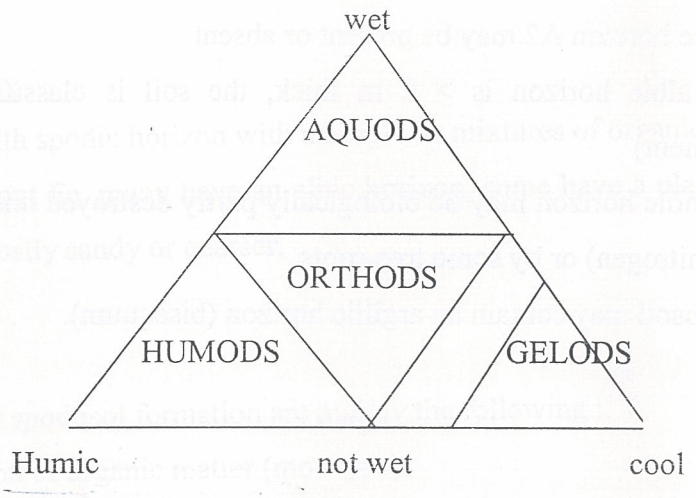
Cryods

(-) Other Spodosols that have ≥6 % organic carbon in layer ≥10 cm thick within a spodic horizon.

Humods

(-) Other Spodosols

Orthods



SUBORDERS AND GREAT GROUPS OF SPODOSOLS

AQUODS

Central concept :

Wet spodosols; fluctuating ground water or extremely humid climate.

Vegetation : water-loving plants : sphagnum (cold) to palms (tropics)

Definition : see key of the suborders

Great groups :

(-) Aquods having a cryic soil temperature regime

Cryaquods

(-) Other Aquods having < 0.1 % Fe (ammonium oxalate) in ≥75 % of the spodic horizon

Alaquods

(-) Other Aquods having a fragipan with its upper boundary within 100 cm.

Fragiaquods

(-) Other Aquods having a placic horizon within 100 cm in ≥50 % of each pedon.

Placaquods

(-) Other Aquods having ≥90 % of each pedon, cemented soil layer that has its upper boundary within 100 cm

Duraquods

(-) Other Aquods having episaturation

Epiaquods

(-) Other Aquods.

Endoaquods

GELODS

(-) Gelods that have ≥6 % organic carbon throughout a layer ≥10 cm thick within the spodic horizon.

Humigelods

(-) Other Gelods

Haplogelods

CRYODS

Definition : see key of suborders

Great groups :

(-) Cryods having a placic horizon within 100 cm in ≥50 % of each pedon.

Placocryods

(-) Other Cryods that have in ≥90 % of each pedon, a cemented soil layer that does not slake in water after air drying and has its upper boundary within 100 cm.

Duricryods

(-) Other Cryods that have ≥6 % organic carbon throughout a layer ≥10 cm thick within the spodic horizon.

Humicryods

(-) Other Cryods.

Haplocryods

HUMODS

Central concept :

Spodosols with large accumulation of organic carbon relative to Fe in the spodic horizon. The Bh horizon is nearly black with a reddish hue. An A2 may be present.

Vegetation : coniferous forest, heath (calluna).

Great groups :

(-) Humods having a placic horizon within 100 cm in ≥50 % of each pedon.

Placohumods

(-) Other Humods or as Duricryods

Durihumods

(-) Other Humods having a fragipan with its upper boundary within 100 cm.

Fragihumods

(-) Other Humods

Haplohumods

ORTHODS

Central concept :

Spodosols with accumulation of Al, Fe, organic carbon in wich no one of those elements dominates.

Vegetation : conifers or hardwoods

Great groups :

(-) Orthods that have in ≥50 % of each pedon a placic horizon within 100 cm.

Placorthods

(-) Other Orthods as Duricryods

Durorthods

(-) Other Orthods having a fragipan with its upper boundary within 100 cm.

Fragiorthods

(-) Other Orthods having < 0.1 % Fe (ammonium oxalate) in ≥75 % of the spodic horizon.

Alorthods

(-) Other Orthods

Haplorthods

ALFISOLS

Central concept :

Soils with ochric epipedon, argillic horizon, moderate to high V, available water (<15 bar) during > 3 months when the soil is warm enough for plant to grow.

Genesis : the following processes may contribute to the formation to alfisols :

- Leaching of carbonates and brownification
- Eluviation of clay from the A horizon (lessivage)
- Illuviation of clay into the B horizon
- Neoformation of clay in the B horizon by weathering.

The Bt horizon may be partially destroyed (tonguing of the A2) by superficial podzolisation; at the same moment a fragipan may from in the Bt.

Diagnostic horizon :

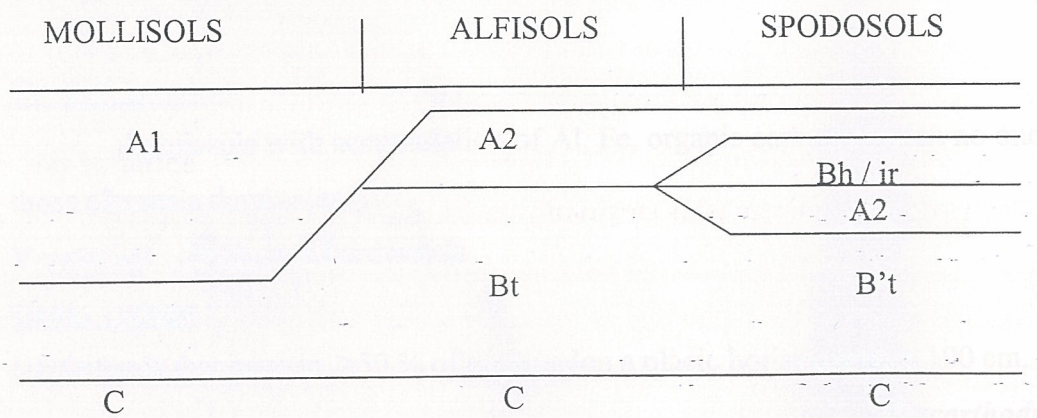
Epipedons : ochric, umbric, anthropic, and mollic

Subsurface : Argillic, natric, albic horizon

Fragipan, duripan, plinthite, (petro) calcic horizon.

Moisture regime : aquic, ustic, udic, and xeric.

Temperature regime : frigid to hyperthermic.



KEY TO SUBORDERS OF ALFISOLS

(-) Alfisols that have, in more horizon within 50 cm an aquic moisture regime (other than anthraquic condition) for some time in normal years (unless artificially drained) and,

(-) 1. Redoximorphic features in all layers between either the lower boundary of an Ap horizon a depth of 25 cm, whichever is deeper, and depth of 40 cm, and within the upper boundary of the argillic, natric, glossic, or kandic have :

(-) 1.1. ≥50 % redox depletions with chroma of ≤2 on peds and redox concentration within peds.

(-) 1.2. Redox concentration an ≥ 50 % redox depletions with chroma of ≤2 in the matrix.

(-) 1.3. ≥50 % redox depletions with chroma of ≤1 on faces of peds or in the matrix.

(-) 2. In the horizons that have aquic condition, enough active ferrous iron to give positive reaction to αα-dipyridyl at time when the soil is not being irrigated.

Aqualfs

(-) Other Alfisols having cryic or isofrigid temperature regime.

Cryalfs

(-) Other Alfisols having an ustic moisture regime.

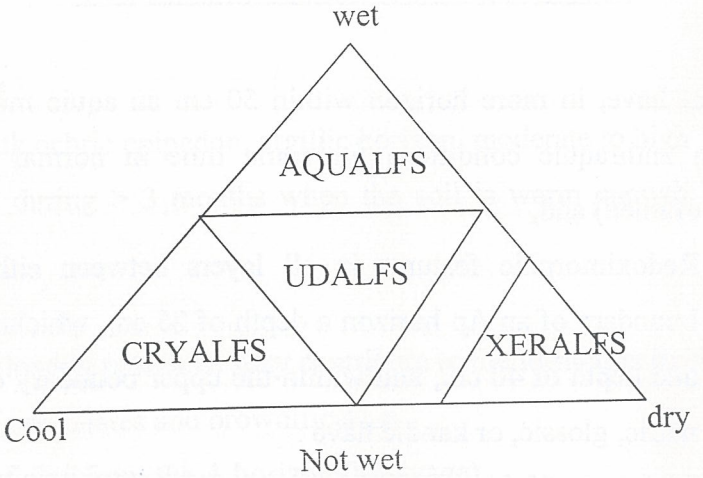
Ustalfs

(-) Other Alfisols having a xeric moisture regime.

Xeralfs

(-) Other Alfisols (udic moisture regime).

Udalfs



SUBORDERS AND GREAT GROUPS OF ALFISOLS

AQUALFS

Central concept :

Gray and mottled Alfisols with an aquic regime.

Definition : see key of the suborders

Great groups :

(-) Aqualfs that have a cryic temperature regime.

Cryaqualfs

(-) Other Aqualfs that have one or more horizons, at a depth between 30 and 150 cm, in which plinthite either forms continuous phase or constitutes ≥1.5 of the volume .

Plinthaqualfs

(-) Other Aqualfs that have a duripan

Duraqualfs

(-) Other Aqualfs that have a natric horizon

Natraqualfs

(-) Other Aqualfs that have a fragipan with upper boundary within 100 cm.

Fragiaqualfs

(-) Other Aqualfs that have a kandic horizon

Kandiaqualfs

(-) Other Aqualfs that have a glossic horizon

Glossaqualfs

(-) Other Aqualfs that have an abrupt textural change between an ochric epipedon or albic horizon and the argillic horizon and have a moderately low or lower hydraulic conductivity in the argillic horizon.

Albaqualfs

(-) Other Aqualfs that have one or more layers, at least 25 cm thick (cumulative) within 100 cm, that have ≥50 % (by volume) recognizable bioturbation, such as filled animal borrows, whormholes, or cast.

Vermaqualfs

(-) Other Aqualfs that have episaturation

Epiaqualfs

(-) Other Aqualfs

Endoaqualfs

CRYALFS

Great groups :

(-) Cryalfs that have

(-) 1. An argillic, kandic, or natric horizon that has its upper boundary ≥ 60 cm below the mineral soil surface and the lower boundary of any surface mantle containing ≥30 % vitric volcanic ash, cinders, or other pyroclastic material.

(-) 2. A texture finer than loamy fine sand in one or more horizon above argillic, kandic, or natric horizon.

(-) 3. Either a glossic horizon or interfingering of albic material into the argillic, kandic, or natric horizon.

Palecryalfs

(-) Other Cryalfs that have a glossic horizon.

Glossocryalfs

(-) Other Cryalfs

Haplocryalfs

USTALFS

Central concept :

Mostly reddish Alfisols of warm subhumid to semi-arid regions.

Moisture regime : ustic

Temperature regime : isothermic or warmer.

Great groups :

(-) Ustalfs that have a duripan that has its upper boundary within 100 cm.

Durustalfs

(-) Other Ustalfs that have one or more horizons within 150 cm in which plinthite either forms a continuous phase or constitute one-half or more of volume.

Plinthustalfs

(-) Other Ustalfs that have a natric horizon.

Natrustalfs

(-) Other Ustalfs that have :

(-) 1. A kandic horizon.

(-) 2. No densic, (para) lithic contact, or petroferric contact within 150 cm.

(-) 3. Within 150 cm :

(-) 3.1. Do not have a clay decrease with increasing depth of ≥20 % (relative) from the maximum clay content,

(-) 3.2. Have ≥5 % (by volume) skeletans on faces of peds in the layer that has a 20 % lower clay content and below that

layer, a clay increase of ≥3 % (absolute) in the fine earth fraction.

Kandiustalfs

(-) Other Ustalfs that have a kandic horizon.

Kanhaplustalfs

(-) Other Ustalfs that have :

(-) 1. A petrocalcic horizon that has its upper boundary within 150 cm.

(-) 2. No densic, (para) lithic contact at < 1.5 m and argillic that has :

(-) 2.1. Within 150 cm of mineral soil surface :

(-) 2.1.1. With increasing depth clay distribution such that the clay % does not decrease from the maximum by ≥20 % at clay is measured non carbonate clay or based on the following formula; clay % : 2.5 (% water retained at pF 4.2 - % organic carbon), whichever value is greater, but no more than 100.

(-) 2.1.2. ≥5 % (by volume) skeletans on faces of peds in the layer that has a 20 % lower clay content and below that layer, a clay increase of ≥3 %.

(-) 2.2. In the lower one-half of the argillic horizon one or more subhorizon with :

(-) 2.2.1. Hues 7.5 YR or redder and chroma of ≥5 in ≥ 50 % of the matrix.

(-) 2.2.2. Common or many coarse redox concentration with hue of 7.5 YR or redder or chroma of ≥6.

(-) 3. No densic , (para) lithic contact within 50 cm an argillic that has

(+) 3.1. A clayey or clayey skeletal particle size class throughout one or more subhorizon in its upper parts.

(+) 3.2. At its upper boundary clay increase of ≥20 % clay or ≥15 % clay (absolute) within a vertical distance of 2.5 cm.

Paleustalfs

(-) Other Ustalfs that have in all subhorizon in the upper boundary within 100 cm of argillic horizon or throughout the intire argillic horizon if less than 100 cm thick more than 50 % color : hue of 2.5 YR or redder, value in moist condition ≤3, and dry value no more than 1 unit higher than moist value.

Rhodustafls

(-) Other Ustalfs

Haplustalfs

XERALFS

Central concept :

Mostly reddish Alfisols of regions with mediterranean climates.

Moisture regime : xeric

Great groups :

(-) Xeralfs that have a duripan that has its upper boundary within 100 cm.

Durixeralfs

(-) Other Xeralfs that have a natric horizon.

Natrixeralfs

(-) Other Xeralfs that have a fragipan that has its upper boundary within 100 cm.

Fragixeralfs

(-) Other Xeralfs that have one or more horizon within 150 cm in which plinthite either forms a continuous phase or constitute one-half or more of the volume.

Plinthoxeralfs

(-) Other Xeralfs that have in all subhorizon in the upper 100 cm of the argillic or kandic horizon or throughout the entire argillic or kandic horizon if less than 100 cm thick, ≥50 % colors hue of 2.5 YR or redder and value moist of ≤3 and dry value no more than 1 unit higher than the moist value.

Rhodoxeralfs

(-) Other Xeralfs that have :

(-) 1. A petrocalcic horizon that has its upper boundary within 150 cm.

(-) 2. No densic, lithic, or paralithic contact within 150 cm and argillic or kandic horizon that has :

(+) 2.1. Within 150 cm

(-) 2.1.1. With increasing depth, no clay decrease ≥20 % (relative) from the maximum clay content [clay is measured non carbonate clay or based on the following formula; clay % : 2.5 (% water retained at pF 4.2 - % organic carbon), whichever value is greater, but no more than 100].

(-) 2.1.2. ≥5 % (by volume) skeletans on faces of peds in the layer that has a 20 % lower clay content and below that layer, a clay increase of ≥ 3 % (absolute).

(+) 2.2. A base at depth of 150 cm.

(-) 3. No densic,or (para) lithic contact within 50 cm and argillic or kandic horizon that has within 15 cm of its upper boundary :

(+) 3.1. A clayey, clayey-skeletal, fine or very fine particle-size class.

(+) 3.2. A clay increase, of either ≥20 % (absolute) within a vertical distance of 7.5 cm or ≥15 % (absolute) within a vertical distance of 2.5 cm.

Palexeralfs

(-) Other Xeralfs

Haploxeralfs

UDALFS

Central concept :

Brownish or reddish alfisols with udic regime and (iso) mesic or warmer regime.

Great groups :

(-) Udalfs that have a natric horizon.

Natrudalfs

(-) Other udalfs that have :

(+) 1. A glossic horizon

(+) 2. In the argillic or kandic horizon, discrete nodules, 2.5 to 30 cm diameter that :

(+) 2.1. Are enriched with iron and extremely weakly cemented to indurated.

(+) 2.2. Have exteriors with either redder hue or higher chroma than interior.

Ferrudalfs

(-) Other Udalfs that have a glossic horizon and fragipan with an upper boundary within 100 cm.

Fraglossudalfs

(-) Other Udalfs that have a glossic horizon.

Glossudalfs

(-) Other Udalfs that have a fragipan with upper boundary within 100 cm.

Fragiudalfs

(-) Other Udalfs that have:

(+) 1. No densic, (para) lithic contact or petroferric contact within 150 cm.

(+) 2. A kandic horizon

(+) 3. Within 150 cm :

(-) 3.1. Do not have a clay decrease with increasing depth of ≥20 % (relative) from the maximum clay content [clay is measured non carbonate clay or based on the following formula; clay % : 2.5 (% water retained at pF 4.2 - %

organic carbon), whichever value is greater, but no more than 100].

(-) 3.2. ≥5 % (by volume) skeletans on faces of peds in the layer that has a 20 % lower clay content and below that layer, a clay increase of ≥3 % (absolute) in the fine earth fraction.

Kandiudalfs

(-) Other Udalfs that have a kandic horizon.

Kanhapludalfs

(-) Other Udalfs that

(+) 1. Do not have a densic, (para) lithic contact within 150 cm.

(+) 2. Within 150 cm of the mineral soil surface :

(-) 2.1. Do not have a clay decrease with increasing depth of ≥20 % (relative) from the maximum clay content [clay is measured non carbonate clay or based on the following formula; clay % : 2.5 (% water retained at pF 4.2 - % organic carbon), whichever value is greater, but no more than 100].

(-) 2.2. ≥5 % (by volume) skeletans on faces of peds in the layer that has a 20 % lower clay content and below that layer, a clay increase of ≥3 % (absolute).

(+) 3. Have an argillic horizon with :

(-) 3.1. In ≥50 % of the matrix of one or more subhorizons in its lower one-half the total thickness, hue of 5 YR or redder or chroma ≥6 or both, in ≥1 subhorizon.

(-) 3.2. In ≥50 % of the matrix of horizon that total; more than one-half the total thickness, hue of 2.5 YR or redder, value moist ≤3 and have dry value of ≤4.

(-) 3.3. Many coarse redox concentration with hue of 5 YR or redder or chroma ≥6, or both, in ≥1 subhorizon.

(-) 4. Have a frigid temperature regime and :

(+) 4.1. An argillic horizon that has its upper boundary ≥60 % below both :

(+) 4.1.1. The mineral soil surfsce

(+) 4.1.2. The lower boundary of any surface mantle containing ≥30 % vitric volcanic ash, cinder, or other vitric pyroclastic material.

(+) 4.2. A texture finer than loamy fine sand, in ≥1 horizons above the argilic horizon.

(+) 4.3. Either a glossic horizon or interfingering of albic materials into the argillic horizon.

Paleudalfs

(-) Other Udalfs that have, in all subhorizon in the upper 100 cm of the argillic horizon or throughout the entire argillic horizon if less than 100 cm thick, more than 50 % colors, with hue of 2.5 YR or redder and moist value ≤3, and dry value not more than 1 unit higher than moist values.

Rhodudalfs

(-) Other Udalfs

Hapludalfs

ULTISOLS

Central concept :

Soils of mid to low latitudes with an argillic horizon with low base saturation that decreases with depth. The color of Ultisols is often redder than that of Alfisols.

Genesis :

The leaching processes (lesivage) in the ultisols are much stronger than in the Alfisols, with even incipients podzolization; the leads to alow base saturation. The neoformation of clay minerals in the Bt horizon is very important.

Diagnostic horizons ;

Epipedons : Ochric, umbric, anthropic, mollic,

Subsurface : Argillic, albic horizon
Fragipan, and plinthite.

Climate : warm humid with seasonal deficit of precipitation.

Temperature regime : warmer than (iso) frigid.

Moisture regime : Udic, ustic, xeric.

KEY TO THE SUBORDERS OF ULTISOLS

(-) Ultisols that have aquic condition for some time in normal years (or artificial drainage) in ≥1 horizons within 50 cm of the mineral soil surface and one or both of the following :

(-) 1. Redoximorphic features in all layers between either the lower boundary of an Ap horizon or a depth of 25 cm, whichever is deeper, and a depth 40 cm, and within the upper 12.5 cm of the argillic or kandic horizon :

(-) 1.1. Redox concentration and ≥ 50 % redox depletion with chroma of ≤2 on faces peds, or in the matrix

(-) 1.2. ≥50 % redox depletion with chroma of ≤1 on faces of peds or in the matrix.

(-) 1.3. Distinct or prominent redox concentration an ≥50 hue of 2.5 Y or 5 Y in the matrix and also a thermic, isothermic, or warmer soil temperature regime.

(-) 2. Within 50 cm, enough active ferrous iron to give positif reaction to $\alpha\alpha$ dipyridyl at time when the soil is not being irrigated.

Aquults

(-) Other Ultisols that have :

(-) 1. ≥0.9 % organic carbon in the upper 15 cm of the argillic or kandic horizon

(-) 2. ≥12 kg/m^2 organic carbon between the mineral soil surface and a depth of 100 cm.

Humults

(-) Other Ultisols that have an udic moisture regime.

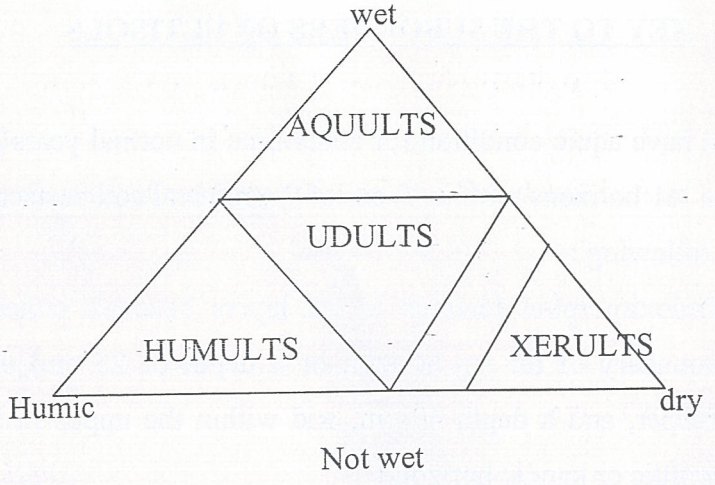
Udults

(-) Other Ultisols that have an ustic moisture regime.

Ustults

(-) Other Ultisols.

Xerults



SUBORDERS AND GREAT GROUPS OF THE ULTISOLS

AQUULTS

Central concept :

Gray or olive wet Ultisols.

Ochric epipedon + argillic horizon (+ fragipan, plinthite)

Great groups :

(-) Aquults that have ≥1 horizons within 150 cm in which plinthite either forms a continuous phase or a constitute one-half or more of the volume.

Plinthaquults

(-) Other Aquults that have a fragipan with upper boundary within 100 cm.

Fragiaquults

(-) Other Aquults that have an abrupt textural change between the ochric epipedon or albic horizon and the argillic or kandic horizon and have 0.4 cm/hr or slower (moderately low and lower) saturated hydraulic conductivity in the argillic or kandic horizon.

Albaquults

(-) Other Aquults that :

(+) 1. No densic, (para) lithic, or petroferric contact within 150 cm.

(+) 2. Have a kandic horizon.

(+) 3. Within 150 cm :

(-) 3.1 Do not have a clay decrease with increasing depth of ≥20 % (relative) from the maximum clay content,

(-) 3.2. Have ≥5 % (by volume) skeletans on faces of peds in the layer that has a 20 % lower clay content and below that layer, a clay increase of ≥3 % (absolute) in the fine earth fraction.

Kandiaquults

(-) Other Aquults that have a kandic horizon.

Kanhaplaquults

(-) Other Aquults that

(+) 1. Do not have a densic, (para) lithic, or petroferric contact within 150 cm.

(+) 2. Within 150 cm :

(-) 2.1. Do not have a clay decrease with increasing depth of ≥20 % (relative) from the maximum clay content,

(-) 2.2. Have ≥5 % (by volume) skeletans on faces of peds in the layer that has a 20 % lower clay content and below that layer, a clay increase of ≥3 % (absolute).

Paleaquults

(-) Other Aquults that have an umbric or mollic epipedon.

Umbraquults

(-) Other Aquults that have episaturation.

Epiaquults

(-) Other Aquults.

Endoaquults

HUMULTS

Central concept :

Humus rich Ultisols of mid or low latitudes, mainly on mountaineous areas.

Great groups :

(-) Humults that have a sombric horizon at < 1 m.

Sombrihumults

(-) Other Humult that have one or more horizons within 150 cm in which plinthite either forms a continuous phase or a constitute one-half or more of the volume.

Plinthohumults

(-) Other Humults that have :

(+) 1. No densic, (para) lithic, or petroferric contact within 150 cm.

(+) 2. Have a kandic horizon.

(+) 3. Within 150 cm :

(-) 3.1. Do not have a clay decrease with increasing depth of ≥20 % (relative) from the maximum clay content,

(-) 3.2. Have ≥5 % (by volume) skeletans on faces of peds in the layer that has a 20 % lower clay content and below that layer, a clay increase of ≥3 % (absolute) in the fine earth fraction.

Kandihumults

(-) Other Humults that have a kandic horizon.

Kanhaplohumults

(-) Other Humults that :

(+) 1. Do not have a densic, (para) lithic, or petroferric contact within 150 cm.

(+) 2. Within 150 cm :

(-) 2.1. Do not have a clay decrease with increasing depth of ≥20 % (relative) from the maximum clay content,

(-) 2.2. Have ≥5 % (by volume) skeletans on faces of peds in the layer that has a 20 % lower clay content and below that layer, a clay increase of ≥3 % (absolute).

Palehumults

(-) Other Humults.

Haplohumuults

UDULTS

Central concept

Humus poor Ultisols of humid climates with well distributed rainfall in mid or low latitudes.

Moisture regime : Udic

Temperature regime : (iso) mesic or warmer.

Great groups :

(-) Udults that have one or more horizons within 150 cm in which plinthite either forms a continuous phase or a constitute one-half or more of the volume.

Plinthudults

(-) Other Udults that have a fragipan with upper boundary within 100 cm.

Fragiudults

(-) Other Udults that have :

(+) 1. No densic, (para) lithic, or petroferric contact within 150 cm.

(+) 2. Have a kandic horizon.

(+) 3. Within 150 cm :

(-) 3.1. Do not have a clay decrease with increasing depth of ≥20 % (relative) from the maximum clay content,

(-) 3.2. Have ≥5 % (by volume) clay depletion on faces of peds in the layer that has a 20 % lower clay content and below that layer, a clay increase of ≥3 % (absolute) in the fine earth fraction.

Kandiudults

(-) Other Udults that have a kandic horizon.

Kanhapludults

(-) Other udults that :

(+) 1. Do not have a densic, (para) lithic, or petroferric contact within 150 cm.

(+) 2. Within 150 cm :

(-) 2.1. Do not have a clay decrease with increasing depth of ≥20 % (relative) from the maximum clay content,

(-) 2.2. Have ≥5 % (by volume) clay depletion on faces of peds in the layer that has a 20 % lower clay content and below that layer, a clay increase of ≥3 % (absolute).

Paleudults

(-) Other Udults that have :

(+) 1. An epipedon with moist values of ≤3 throughout

(+) 2. In all subhorizons in the upper of the argillic horizon or throughout the entire argillic horizon if its less than 100 cm thick, more than 50 % colors :

(+) 2.1. Hue of 2.5 YR or redder

(+) 2.2. A value moist, of ≤3

(+) 2.3. A dry value no more than 1 unit higher than the moist value.

Rhodudults

(-) Other Udults.

Hapludults.

USTULTS

Central concept :

Ultisols of warm regions with high rainfall but a pronounced dry season (or with two dry and two rainy season). Colors are reddish or yellowish brown in the surface, redder at depth.

Moisture regime : Ustic

Temperature regime ; (iso) thermic or warmer.

Great groups :

(-) Ustults that have one or more horizons within 150 cm in which plinthite either forms a continuous phase or a constitute one-half or more of the volume.

Plinthustults

(-) Other Ustults that have :

(+) 1. No densic, (para) lithic, or petroferric contact within 150 cm.

(+) 2. Have a kandic horizon.

(+) 3. Within 150 cm :

(-) 3.1. Do not have a clay decrease with increasing depth of ≥20 % (relative) from the maximum clay content,

(-) 3.2. Have ≥5 % (by volume) skeletans on faces of peds in the layer that has a 20 % lower clay content and below that layer, a clay increase of ≥3 % (absolute) in the fine earth fraction.

Kandiustults

(-) Other Ustults that have a kandic horizon.

Kanhaplustults

(-) Other Ustult that :

(+) 1. Do not have a densic, (para) lithic, or petroferric contact within 150 cm.

(+) 2. Within 150 cm :

(-) 2.1. Do not have a clay decrease with increasing depth of ≥20 % (relative) from the maximum clay content,

(-) 2.2. Have ≥5 % (by volume) clay depletion on faces of peds in the layer that has a 20 % lower clay content and, below that layer, a clay increase of ≥3 % (absolute).

Paleustults

(-) Other Ustults that have :

(+) 1. An epipedon with moist values of ≤3 throughout

(+) 2. In all subhorizons in the upper of the argillic horizon or throughout the entire argillic horizon if its less than 100 cm thick, more than 50 % colors :

(+) 2.1. Hue of 2.5 YR or redder

(+) 2.2. A value moist, of ≤3

(+) 2.3. A dry value no more than 1 unit higher than the moist value.

Rhodustults

(-) Other Ustults

Haplustults

XERULTS

Central concept :

Ultisols of regions with mediterranean climate.

Ochric epipedon + brownish or reddish argillic horizon.

Temperature regime : thermic or mesic

Moisture regime : Xeric

Great groups :

(-) Xerults that :

(+) 1. Do not have a densic, (para) lithic, or petroferric contact within 150 cm.

(+) 2. Within 150 cm :

(-) 2.1. Do not have a clay decrease with increasing depth of ≥20 % (relative) from the maximum clay content,

(-) 2.2. Have ≥5 % (by volume) clay depletion on faces of peds in the layer that has a 20 % lower clay content and, below that layer, a clay increase of ≥3 % (absolute).

Palexerults

(-) Other Xerults

Haploxerults

OXISOLS

Central concept :

Reddish, yellowish or grayish soils of intertropical regions with mostly gently slopes on surfaces of great age. Primarily mixtures of quartz, kaolin, free oxides and organic matter. No clearly marked horizon. Horizon boundaries are mostly arbitary. High weathering, thick regolith.

Genesis ;

The weathering is extremely high, leading to :

- Decompotition of weatherable minerals and 2 : 1 clays,
- Desillication, formation of 1 : 1 clays, free iron, gibbsite,
- With fluctuating water table : formation of plinthite.

Diagnostic horizon :

Epipedon : Ochric, umbric, and mollic.

Subsurface : Oxic, sombric horizon, and plinthite.

Temperature regime : Mostly (iso) thermic or warmer.

Moisture regime : any.

Remarks :

1. Not all soils previously classified as latosol or lateric soil are oxisols (some of them are Alfisols, Ultisols, Inceptisols).
2. Not all soils in the intertropical zone are Oxisols.

KEY TO THE SUBORDERS OF OXISOLS

(-) Oxisols that have aquic condition for some time in normal years (or artificial drainage) in one or more horizon within 50 cm and have :

(-) 1. A histic epipedon

(-) 2. An epipedon with a color value, moist of ≤3, and directly below it, a horizon with chroma of ≤2.

(-) 3. Distinct prominent redox concentration within 50 cm, an epipedon, and directly below it, a horizon with one or both :

(-) 3.1. ≥50 % hue of 2.5 YR or redder

(-) 3.2. Chroma of ≤3.

(-) 4. Within 50 cm, enough active ferrous iron to give positive reaction to $\alpha\alpha$ dipyridyl at time when the soil is not being irrigated.

Aquox

(-) Other Oxisols that have an aridic moisture regime.

Torrox

(-) Other Oxisols that have an ustic moisture regime.

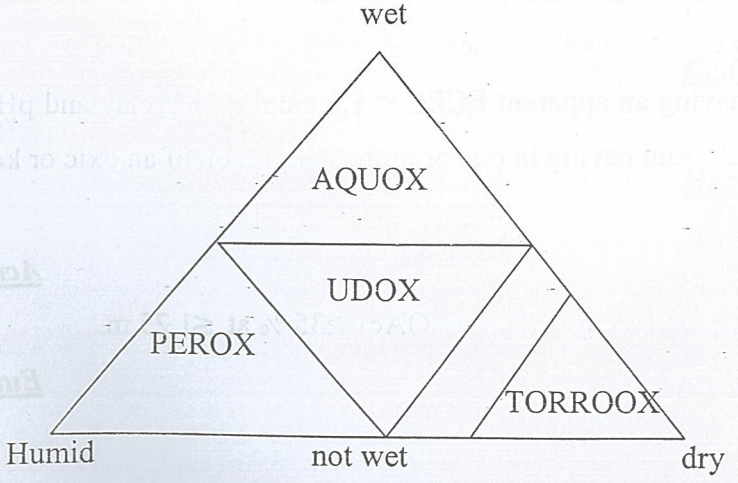
Ustox

(-) Other Oxisols that have a perudic moisture regime.

Perox

(-) Other Oxisols.

Udox



SUBORDERS AND GREAT GROUPS OF OXISOLS

AQUOX

Central concept :

Wet Oxisols.

Definition : see key to the suborders.

Great groups :

(-) Aquox having an apparent ECEC < 1.5 cmol (+)/kg clay and pH value (1 N KCL) ≥5. And having in one or more subhorizon of an oxic or kandic within 150 cm.

Acraquox

(-) Other Aquox having plinthite that forms a continuous phase within 1.25 m.

Plinthaquox

(-) Other Aquox having V (by NH_4OAc) ≥35 % at ≤1.25 m.

Eutraquox

(-) Other Aquox.

Haplaquox

TORROX

Central concept :

Oxisols of arid climates.

Great groups :

(-) Torrox having an apparent ECEC < 1.5 cmol (+)/kg clay and pH value (1 N KCL) ≥5. And having in one or more subhorizon of an oxic or kandic within 150 cm.

Acrotorrox

(-) Other Torrox having V (by NH_4OAc) ≥35 % at ≤1.25 m.

Eutrotorrox

(-) Other Torrox

Haplotorrox

USTOX

Central concept :

Red Oxisols, dry in the control section for long periods.

Definition :

(+) 1. Ustic regime

(+) 2. (Iso) thermic or warmer regime.

(+) 3. < 16 kg organic carbon/m^2.

Great groups :

(-) Ustox having a sombric horizon within 150 cm.

Sombriustox

(-) Other Ustox having an apparent ECEC < 1.5 cmol (+)/kg clay and pH value (1 N KCL) ≥5. And having in one or more subhorizon of an oxic or kandic within 150 cm.

Acrustox

(-) Other Ustox having V (by NH_4OAc) ≥35 % in all horizon within ≤1.25 m.

Eutrustox

(-) Other Ustox having a kandic horizon that has its upper boundary within 150 cm.

Kandiustox

(-) Other Ustox

Haplustox

PEROX

Central concept :

Oxisols of relatively cool humid climates of (relatively) high latitudes. Reddish in hue; dark in color, low chroma in the top. High contens of organic carbon. Low supply af bases.

Moisture regime : (per) udic.

Temperature regime : (iso) thermic.

Great groups :

(-) Perox having a sombric horizon within 150 cm.

Sombriperox

(-) Other Perox having an apparent ECEC < 1.5 cmol (+)/kg clay and pH value (1 N KCL) ≥5. And having in one or more subhorizon of an oxic or kandic within 150 cm.

Acroperox

(-) Other perox having V (by NH_4OAc) ≥35 % at ≤1.25 m.

Eutroperox

(-) Other Perox having a kandic horizon that has its upper boundary within 150 cm.

Kandiperox

(-) Other Perox

Haploperox

UDOX

Central concept :

Oxisols with short or no dry seasons. Near the equator. Yellowish to reddish (5 YR-10 YR and high chroma).

Great groups :

(-) Udox having a sombric horizon within 150 cm.

Sombriudox

(-) Other Udox having an apparent ECEC < 1.5 cmol (+)/kg clay and pH value (1 N KCL) ≥5. And having in one or more subhorizon of an oxic or kandic within 150 cm.

Acrudox

(-) Other Udox having V (by NH_4OAc) ≥35 % at ≤1.25 m.

Eutrudox

(-) Other Udox having a kandic horizon that has its upper boundary within 150 cm.

Kandiudox

(-) Other Udox

Hapludox

HISTOSOLS

Central concept :

Organic soils. They are mostly associated with aquic suborders.

Genesis :

When the production of organic matter exceeds its minerlization (mostly under continuous saturation with water), the decomposition is slowed and permits its accumulation. The following processes take place ;

- initial process : paludization, the histosols growing up from the bottom,
- decompotition of organic matter : ripening :
  - physical : decrease in volume
  - chemical : chemical decomposition of organic components
  - biological : reduction in particle size and mixing by living organisms

Moisture regime : (per) udic.

Definition : see definition "organic soils" and "minerals soils".

Classification :

The state of decomposition is an important criterion for classification of organic soils. In order of increasing decomposition we distinguish :

Fibric horizons : Oi

Hemic horizons : Oe

Sapric horizons : Oa.

KEY TO THE SUBORDERS OF HISTOSOLS

Suborders : defined by moisture regime and degree of decomposition.

(-) Histosols which are saturated with water for less than 30 days (cumulative) during normal years (and not artificially drained)

Folist

(-) Other Histosols that :

(+) 1. Have more thickness of fibric soil material, than any other organic soil material either :

(-) 1.1. In the organic parts of the subsurface tier if there is no continuous mineral layer ≥40 cm thick that has its upper boundary within the subsurface tier.

(-) 1.2. In the combined thickness of the organic parts of the surface and subsurface tiers if there is continuous mineral layer ≥40 cm thick that has its upper boundary within the subsurface tier.

(+) 2. Do not have sulfuric horizon that has its upper boundary within 50 cm.

(+) 3. Do not have sulfidic material within 100 cm.

Fibrists

(-) Other Histosols that have more thickness of sapric soil material than other kind of organic soil material either :

(-) 1. In the organic parts of the subsurface tier if there is no continuous mineral layer ≥40 cm thick that has its upper boundary within the subsurface tier.

(-) 2. In the combined thickness of the organic parts of the surface and subsurface tiers if there is continuous mineral layer ≥40 cm thick that has its upper boundary within the subsurface tier.

Saprists

(-) Other Histosols

Hemists

SUBORDERS AND GREAT GROUPS OF HISTOSOLS

FOLISTS

Definition : see key to the suborders.

Great groups :

(-) Folists that have a cryic soil temperature regime.

Cryofolists.

(-) Other Folists that have an aridic (or torric) soil temperature regime.

Torrifolists

(-) Other Folists that have an ustic or xeric moisture regime.

Ustifolists

(-) Other Folists.

Udifolists

FIBRISTS

Definition : see key to the suborders

Great groups :

(-) Fibrists that have a cryic temperature regime.

Cryofibrists

(-) Other Fibrists in which fibric sphagnum constitutes three-fourth or more of the volume a depth of 90 cm or to densic, (para) lithic contact fragmental material, or other mineral soil material if at a depth less than 90 cm.

Spagnofibrists

(-) Other Fibrists

Haplofibrists

HEMISTS

Definition : see key to the suborders.

Great groups :

(-) Hemists that have a sulfuric horizon that has its upper boundary within 50 cm of the soil surface.

Sulfohemists

(-) Other Hemists that have a sulfidic material within 100 cm of the soil surface.

Sulfihemists

(-) Other Hemists that have a horizon ≥2 cm thick in which humilluvic materials constitute one half or more of the volume.

Luvihemists

(-) Other Hemists that have a cryic soil temperature regime.

Cryohemists

(-) Other Hemists.

Haplohemists.

SAPRISTS

Definition : see key to the suborders.

Great groups :

(-) Saprists that have a sulfuric horizon that has its upper boundary within 50 cm of the soil surface.

Sulfosaprists

(-) Other Saprists that have a sulfidic material within 100 cm of the soil surface.

Sulfisaprists

(-) Other Saprist that have a cryic soil temperature regime.

Cryosaprists

(-) Other Saprists.

Haplosaprists

GELISOLS

Central concept :

Soils with gelic material underlying by permafrost. Freezing and thawing are important processes in Gelisols. Diagnostic horizons may or may not be present. Permafrost influences pedogenesis by acting as barrier to downward movement of the soil solution.

Genesis :

Permafrost influences by acting as barrier to downward movement of the soil solution.

Cryoturbation (frost mixing) is an important process in many Gelisols and result in irregular or broken horizons, involution, organic matter accumulation on the permafrost table, oriented rock fragment, and silt capson rock fragment.

Location	: Lower Kolymar, Russia.
Diagostic horizon	: May or may not be present.
Epipedon	: Ochric, mollic, umbric, and histic
Subsurface	: Argillic, salic, gypsic, and calcic.
Moisture regime	: Udic
Vegetation	: Forest (not grazed)

KEY TO SUBORDERS OF GELISOLS

(-) Gelisols that have organic soil material that meet one or more of the following

(-) 1. Overlie cindery, fragmental, or pumiceous material and/or fills their interstice and directly below these material have either a densic, or (para) lithic contact.

(-) 2. When added with the underlying cindery, fragmental, or pumiceous material, total ≥40 cm between the soil surface and a depth of 50 cm.

(-) 3. Are saturated with water for ≥30 comulative days during normal years (or are artificially drained) and have ≥80 %, by volume, organic soil materials from the soil surface to a depth 50 cm or to a glacic layer or a densic,or (para) lithic contact, whichever is shallowest.

Histels

(-) Other Gelisols that have one or more horizons showing cryoturbation in the form of irregular, broken, or distorted horizon boundaries, involutions, the accumulation of organic matter on top of the permafrost, ice or sand wedges, and oriented rock fragments.

Turbels

(-) Other Gelisols.

Orthels

SUBORDERS AND GREAT GROUPS OF GELISOLS.

HISTELS

Definition : see key of suborders

Great groups :

(-) Histels that are saturated water for less than 30 comulative days during normal years (and are not artificially drained).

Folistels

(-) Other Histels that are saturated with water for ≥30 cumulative days during normal years and that have :

(+) 1. A glasic layer with its upper boundary within 100 cm.

(+) 2. Less than three-fourth (by volume) sphagnum fibers in the organic soil material, to depth of 50 cm or to densic, and (para) lithic contact, whichever is shallowest.

Glacistels

(-) Other Histels that have more thickness of fibric soil material than any other kind of organic soil material to a depth of 50 cm or to densic, (para) lithic contact, whichever is shallowest.

Fibristels

(-) Other Histels that have more thickness of hemic soil material than any other kind of organic soil material to a depth of 50 cm or to densic, (para) lithic contact, whichever is shallowest.

Hemistels

(-) Other Histels.

Sapristels

TURBELS

Definition : see key of suborders

Great groups :

(-) Turbels that have in ≥30 % of pedon > 40 %, by volume, organic materials from the soil surface to a depth of 50 cm.

Histoturbels

(-) Other Turbels that have, within 50 cm, redox depletion with chroma of ≤2 and also give aquic condition during normal years (or artificial drainage).

Aquiturbels

(-) Other Turbels that have anhydrous condition.

Anhyturbels

(-) Other Turbels that have a mollic epipedon.

Molliturbels

(-) Other Turbels that have an umbric epipedon.

Umbriturbels

(-) Other Turbels that have less than 35 % (by volume) rock fragments and a texture of loamy fine sand or coarser in all layer.

Psammoturbels

(-) Other Turbels.

Haploturbels

ORTHELS

(-) Orthels that have in ≥30 % of pedon 40 % by volume, organic soil material to a depth of 50 cm.

Historthels

(-) Other Orthels that have, within 50 cm, redox depletions with chroma ≤2 and also aquic condition during normal years (or artificial drainage).

Aquorthels

(-) Other Orthels that have anhydrous condition.

Anhyorthels

(-) Other Orthels that have a mollic epipedon.

Mollorthels

(-) Other Orthels that have an umbric epipedon.

Umbrorthels

(-) Other Orthels that have an argillic horizon that has its upper boundary within 100 cm.

Argiorthels

(-) Other Orthels that have, below the Ap horizon or below a depth of 25 cm, whichever is deeper, less than 35 % (by volume) rock fragments and have texture of loamy fine sand or coarser.

Psammorthels

(-) Other Orthels.

Haplorthels

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